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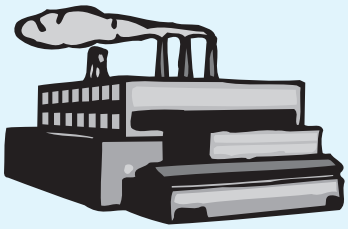
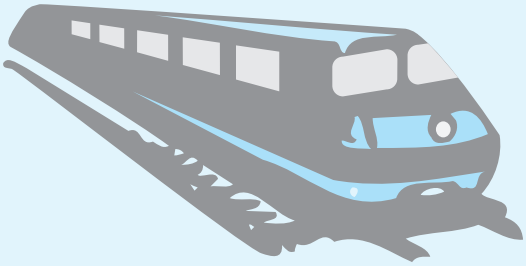


Systems Engineering Application Domains in the Commercial and Public Interest



INCOSE
INSIGHT
A PUBLICATION OF THE INTERNATIONAL COUNCIL OF SYSTEMS ENGINEERING

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Copy Editors: Donna Rhodes, Lori Pajerek, Shirley Bishop

Who are we? INCOSE is a 3000+ member organization of systems engineers and others interested in systems engineering. Its purpose is to foster the definition, understanding, and practice of world class systems engineering in industry, government, and academia. INCOSE is comprised of chapters located in cities worldwide and is sponsored by a corporate advisory board and led by elected officers, Regional Directors, and Directors-at-Large.

From the Editor

SE Application Domains in the Public and Private Interest

The theme of this issue of ***INSIGHT*** is "SE Application Domains in the Public and Private Interest." The articles presented illustrate that Systems Engineering is being applied to an increasing set of industries. A product, in order to be successful, must not only have a real world application, but also have a method for marketing it. Each article presents ideas on how Systems Engineering (SE) may be applied to a domain.

The sequence of articles begins with an overview of the Systems Engineering Applications Technical Committee (SEATC) by William Mackey. When reading this article, it is important to remember that the SEATC is dedicated to focusing on SE applications in diverse domains in government, academia and private industry.

The next article looks at SE and the Commercial Aircraft Domain. Scott Jackson maps the traditional SE lifecycle functions to the those used in the aircraft industry. This mapping technique could be a useful tool to translate how SE works in any domain.

In telecommunications, there are compelling reasons why SE is vital to that domain. Thomas Bagg describes how complexity in the telecommunication domain has greatly increased. As the complexity increases in any domain, the proper application of the Systems Engineering process plays a crucial role in that domain's ultimate success.

In yet another domain, my own article on systems engineering in facilities provides a model to describe the interaction of the SE process with the processes normally associated with facility operations and maintenance. Similar to the chart in the commercial aircraft article, this model describes these interactions in a complex facilities environment. The model can be a useful marketing tool for selling the SE process to the stakeholders in this domain.

The final article, written by Mark Austin, addresses the Systems Engineering Applications Profile (SEAP). This resource is intended to serve the SE community as a source of information on many aspects of SE applications for a wide variety of domains. This article also discusses the power of providing this resource on the World Wide Web (the prototype of this application is available at: http://www.isr.umd.edu/~austin/ense623.html.

The examples discussed in this issue are intended to stimulate thought on how INCOSE can continue to promote Systems Engineering in diverse domains. As more industries seek methods to increase their profitability and to address increasing complexity, the application of Systems Engineering can become the key to their success. The SEATC is looking for inputs from any domain. If anyone would like to share examples of how the application of Systems Engineering has been accomplished in their domain, please contact any of the authors.

The ***INSIGHT*** staff hopes you enjoy the first theme issue of this publication. Comments are welcomed by the managing and theme editor.

Pat Sweeney
Theme Editor

Systems Engineering Applications Technical Committee Activities

William Mackey, wmackey@cscmail.csc.com

The Systems Engineering Applications Technical Committee (SEATC) is chartered to "Foster the formation and operation of working groups (WGs) and interest groups (IGs) within specific application domains and across domains; and examine systems engineering tools, techniques, and processes within specific application domains." It is the only INCOSE Technical Committee solely focused on systems engineering applications in government, academia and private industry.

The SEATC met in Dallas in January 1998 to revitalize the work of the SEATC and to prepare for the summer symposium in Vancouver. We were pleased that a few people accomplished a great amount of work. This summary attempts to explain the recent activities of the SEATC and indicate the direction that the members advanced in Dallas.

At present, the following WGs/IGs comprise the SEATC:

- *Applications Forum WG* led by Mark Austin (austin@isr.umd.edu, 301-405-6627) and William Mackey (wmackey@cscmail.csc.com, 301-794-1966)
- *Facilities Systems Engineering WG* led by Pat Sweeney (sweeney@hap.arnold.af.mil, 615-454-4709) and Bill Henderson (hendersonwf@hap.arnold.af.mil, 615-454-5295)
- *Telecommunications WG* led by Tom Bagg (tom.bagg@gsfc.nasa.gov, 301-809-2216) and Kip Klish (klish@aur.alcatel.com)
- *DOE SE Practices IG* led by Sam Rindskopf (m.sam_rindskopf@notes.ymp.gov, 702-295-3943) and Norm Cole (ncole@inel.gov, 208-526-5004)
- *Resource Management IG* led by Ted Dolton (alanjoanne@aol.com, 408-743-1358) and Bill Cutler (billcutler@compuserve.com, 650-493-8715)

The Business Domain Analysis WG was consolidated into the AFWG and Government Applications IG was dissolved. Two new IGs are in the process of being formed as a result of increased interest in these application domains, namely:

- *Commercial Aviation IG* led by Joe Simpson (joseph.j.simpson@boeing.com)
- *Railroad Transportation IG* led by our first international chairman from the United Kingdom, John Williams (jsw@netcomuk.co.uk)

If you believe you have experience or significant interest in one of these groups, please let the chairpersons know at your earliest convenience.

Evolution of SEATC IG/WG Development: In order to monitor the status of the SEATC organization, in 1997 we established a criteria for the evolution of IGs/WGs. We annually evaluate each of the groups against the criteria. The eight step criteria are:

Interest Group Progression steps:

1. Develop charter for IG/WG
2. Develop 1-year goals
3. Create nucleus of 3 to 6+ interested members
4. Identify potential WG products

Working Group Progression steps:

5. Create profile for SEAP document
6. Develop WG product(s)
7. Communicate WG activities (via ***INSIGHT***, symposia, Journal)
8. Create liaisons (with local chapters, universities, companies, societies)

With few exceptions, most of the WGs/IGs have satisfied most of these steps.

Goals: In addition to measuring the interest and working group progress against the above criteria, the SEATC has specific goals for each year, and its members work very hard to accomplish them. As of early 1998, here is how we are doing.

Goal 1: Improve and modify the Systems Engineering Applications Profiles (SEAP) document for the Summer Symposium in 1998 and place it on the Web.

Status: The SEAP Version 1.0, was completed on May 1, 1996 and included in Volume 2 of the 1996 Symposium Proceedings. A Facilities Systems Engineering section has recently been added; additional sections will be released soon. Look for Version 2.0 in the 1998 Symposium Proceedings. Also, check the University of Maryland Website that has been built as a prototype for the INCOSE SEAP by Professor Mark Austin, who is now leading the Applications Forum WG (go to EE623 under the following URL: http://www.isr.umd.edu/~austin).

Goal 2: Initiate additional SEATC work products.

Status: The following products have been completed by the WG/IGs:

- *SE Applications Profiles Writing Guide,* April 1, 1996 (completed by the AFWG and enclosed as Appendix E of the following document).
- *Systems Engineering Applications Profiles,* May 1, 1996 (Version 1.0 was included in the 1996 Symposium Proceedings).
- List of SE applications papers from previous INCOSE symposia.
- Panel discussion conducted at the Los Angeles symposium on the topic "Systems Engineering in Commercial Industries."

- The SEATC held application-focused sessions at the 1996 and 1997 symposia, and plans another for 1998.
- The RMIG has conducted seminars and volunteer projects, and become known for its SE services to many government and civic organizations in the San Francisco Bay area.
- The FSEWG has distributed a Facilities SE brochure.

To continue in the maintenance and generation of work products, we need your help with items like:

- New SE applications profiles
- Summaries of SE applications papers
- Case studies of SE applications
- List of SE activities and events of other related societies

Goal 3: Conduct Systems Engineering Applications Sessions at the 8th Annual International Symposium in Vancouver, in July, 1998 on diverse systems engineering applications.

Status: The SEATC Chair has worked with the symposium technical chair to plan five SE Applications paper sessions during the Vancouver Symposium. Twenty papers have been placed into five sessions. Working with the symposium committee, our technical committee proposed the session structure. All of the SE Applications sessions are domain specific. These sessions are:

- Session 1 - Aviation Applications
- Session 2 - Defense and Aerospace Applications
- Session 3 - Telecommunications and Information Systems Applications (new)
- Session 4 - Healthcare Applications (new)
- Session 5 - International Commercial Applications (new)

Goal 4: Conduct a SE Panel Session at the Vancouver Symposium.

Status: The SEATC has proposed two panel sessions for consideration in Vancouver. These sessions are:

- Issues Pertaining to Implementing on the Internet
- Issues Related to Deploying SE in the Commercial and Public Interest Domains

Unfortunately, the number of panel sessions have been reduced in Vancouver and we may have to wait until 1999 in Brighton, England.

Goal 5: Continue contact with universities which offer a Systems Engineering curriculum to gain their participation in the SEATC.

Status: Contacts are underway across the nation with systems engineering students and faculty at universities such as Virginia Tech, George Mason University and the University of Arizona. Several SEATC members are involved in these activities.

In addition, a major program was initiated in 1997 with the University of Maryland. Lead by INCOSE member, Prof. Mark Austin, the program's efforts were to (1) place the Systems Engineering Applications Profiles on the Web and (2) develop JAVA instructional SE modules for specific application domains. Mark and his students have taken the SEAP concept and created a prototype Webpage (the URL is cited above in Goal 1). Try it and you will see dynamic Java SE Case Studies and even a modifiable SE tradeoff analysis you can perform on-line.

Goal 6: Obtain a complement of INCOSE Interest Groups in local chapters.

Status: Several chapters have accepted the challenge and are conducting or proposing programs in their local chapters. The San Francisco Bay Area Chapter has had as many as eight volunteer projects underway in Natural Resource Management. Current chapter activities include:

- San Francisco Bay Area: Natural Resource Management Systems
- Washington Metro: Highway Transportation Systems and/or Criminal Justice and Legal Systems
- Chesapeake: Telecommunications Systems
- Silver State (Nevada): Waste Management and Disposal Systems
- Detroit/Tri-State: Motor Vehicle Systems
- Texas Gulf Coast: Energy Systems
- New England: Health Care Systems

Your Participation is Needed. If you are interested in documenting your SE application, please join one of our WGs/IGs. You can contact me at the email address located in the beginning of the article. Scott Jackson has proposed a system of participant networks using a "Multi-level Participation" concept. The key features of this concept are that:

- members would be able to participate at different levels including from their workstations;
- communications would focus on email and teleconferences (bi-monthly) to conduct our business; and
- networks would be headed by POCs rather than chairs.

So, no matter where you are in the world, you can help. Please give this your consideration.

I wish to thank all of the SEATC members who contributed to the realization of all our goals for 1997 and those who stimulated us in Dallas, Texas to continue the good work in 1998. I hope to see many of you in Vancouver, Canada this summer.

■ **William Mackey, Ph.D., J.D.,** *is a Senior Member of the Executive Staff of CSC. Dr. Mackey is a member of both the District of Columbia and the State of Virginia legal bars. He has served as a key member and Co-chairman of the INCOSE Capability Assessment Working Group for five years, as Chairman of the INCOSE WMA Chapter Application Forum Working Group, and presently is Chairman of the Systems Engineering Applications Technical Committee. Dr. Mackey has presented numerous papers and tutorials at INCOSE international symposiums in topics such as law, highway transportation, space systems development, telecommunications, technology management and systems engineering capability, and has promoted the belief that the discipline provides value to a wide variety of application domains.*

Systems Engineering In the Commercial Aircraft Domain

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SE is increasingly being applied in commercial practice. Petersen and Sutcliffe (1992), for example, discuss the principles of SE as applied to aircraft development.

The Commercial Aircraft Domain. Since the merger of Boeing and McDonnell Douglas, the development of large (100 passengers or more) aircraft is largely limited to Boeing and Airbus. However, several smaller turbofans and turboprops are in development and production in other parts of the world.

Customers and Stakeholders. Following are the customers and stakeholders who ultimately determine the nature of a commercial aircraft:

- Passengers and freight haulers
- Airlines
- Regulatory agencies (FAA, JAA, OSHA, FDA)
- Stockholders
- Suppliers

Drivers. Following are the principal drivers which determine the design of a commercial aircraft:

- Performance (range, payload, weight)
- Safety
- Cost (direct operating and life cycle)
- Reliability (dispatch)
- Fleet commonality (training, maintenance)

Levels of Development. The three levels of aircraft development are: (1) new ("blank slate") aircraft, (2) derivative aircraft (based on previous designs) and (3) change-based aircraft (for specific customers); all of which must meet the top-level requirements.

Architecture of the Aircraft System. Table 1 shows a typical hierarchy for a commercial aircraft system, which includes more than the aircraft itself. The development of this hierarchy is one of the first steps in the aircraft SE synthesis process. This view shows eight segments of the aircraft. Within each segment can be many subsystems. About thirty subsystems are typical.

Table 1. Typical Aircraft System Architecture

Aircraft System	
♦ Aircraft	
• Environmental Segment	• Interiors Segment
• Avionics Segment	• Propulsion Segment
• Electrical Segment	• Auxiliary Segment
• Airframe Segment	• Mechanical Segment
♦ Training	
♦ Facilities	
♦ Support	
♦ Personnel	

New Technologies and Concepts. To meet design requirements for reduced weight, noise, and emissions; for robust systems; and for safe and economic operations, many advanced technologies, such as composite materials, are routinely incorporated into commercial aircraft. Radical changes in aircraft design are being studied, such as the high speed civil transport (HSCT) and the blended wing-body (BWB). Mackey (1996) shows how to evaluate and introduce these technologies into a design.

Lifecycle Functions. The demands of the aircraft industry gives the lifecycle flow its own unique characteristics. Table 2 compares aircraft lifecycle functions with the traditional SE lifecycle functions.

Table 2. Traditional and Aircraft Lifecycle Functions

Traditional SE lifecycle functions	Aircraft lifecycle functions
Development	Market analysis Perform initial marketing Perform initial design Market aircraft Perform design and development
Manufacturing	Perform manufacturing, procurement, and assembly
Verification	Perform design and development Perform certification
Deployment	Operate aircraft
Operations	Operate aircraft
Support	Perform sustainment
Training	Perform sustainment
Disposal	Remove aircraft from service

Aircraft Functions. The operational functions of the aircraft are to perform:

- Pre-flight operations
- Take-off operations
- Flight operations
- Post-landing operations

The Flight Operations functions can be expanded into the following subfunctions; these functions and their subordinate functions drive the subsystem performance requirements:

- Provide aerodynamic performance
- Provide thrust
- Provide passenger and crew accommodations
- Provide cargo capability
- Provide environmental control
- Provide communications
- Provide guidance and navigation
- Maintain structural integrity
- Provide power
- Provide situational awareness

Human Factors. Along with passenger comfort and maintenance, flight deck (cockpit) design is an important area for human factors focus. The human factors requirements for cockpit design require the

Table 3. Requirement Categories for the Aircraft System

Cargo characteristics	Costs
Airport characteristics	Exterior noise
Utilization rate	Operational requirements
Turnaround time	Growth capability
People-related requirements	Aircraft autonomy
Passenger service requirements	Consumables
Regulatory environmental requirements	Reliabilities, both dispatch and operational
Actual origins and destinations	Particular customer requirements

resolution of conflicting requirements resulting from periods of high and low activity. Billings (1997) provides a set of requirements to address these issues.

Synthesis. The five aircraft system elements are synthesized using the requirements in Table 3.

Corning (1977) describes the synthesis of the aircraft itself. It begins with wing sizing based on performance requirements, such as range, and constraints, such as field length, and continues until all the aircraft characteristics are determined.

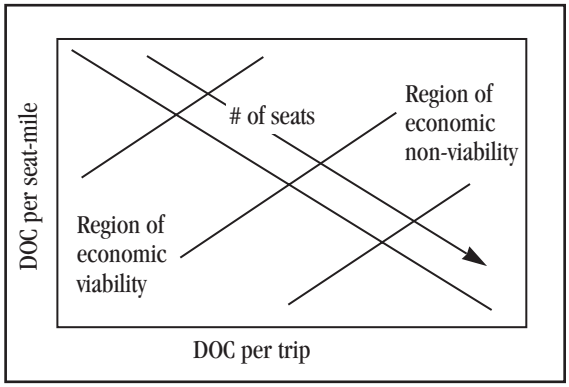

Figure 1. DOC Design Regimes

Economic Constraints. Direct operating cost (DOC) is a primary design constraint. The components of DOC are navigation fees, insurance, landing fees, ground handling, crew (cabin, cockpit), ownership (depreciation and interest), maintenance (engine, airframe), and fuel and oil. Like other requirements, DOC can be allocated to any subsystem of the aircraft. Figure 1 shows how DOC is used to select a design point for a new aircraft. Design points in the lower left-hand corner are deemed to be viable while those in the upper right-hand corner are not.

Subsystem Synthesis. Subsystem requirements are derived from the top level requirements and the subsystem functions. Trade studies are conducted between and within aircraft segments to arrive at the desired subsystem solution.

Interfaces. Because aircraft components are developed in various parts of the world, interfaces are important. Functional interfaces include electrical, hydraulic, and pneumatic power; mechanical forces and torques; conditioned air; heat; vibration; shock; loads; and signals.

Certification. Certification is the process that substantiates that the aircraft and its subsystems comply with airworthiness requirements. The FAA and the SAE have taken a major step towards incorporating the SE process into the certification process with the publication of ARP 4754 (1996). Although the primary focus of certification is safety, certification encompasses the entire development of the aircraft.

Software development is an important part of certification. The process, described by RTCA/DO-178B (1992), is essentially the same as the SE process. The certification process considers software to be a part of a larger system to be certified.

SE Management. As in the military domain, SE management is a critical aspect of commercial aircraft development. Key management aspects include design reviews, supplier management, risk management, and configuration management.

Conclusions. Many changes in aircraft and subsystem concepts are being studied by the aircraft industry. All of these developments will be enhanced by the application of SE during the development cycle.

REFERENCES

ARP 4754, *Guidelines for the Certification of Highly-Integrated and Complex Aircraft Systems, Society of Automotive Engineers* (SAE), November 1996.

Billings, Charles E., *Aviation Automation: The Search for a Human-Centered Approach,* Lawrence Erlbaum Associates: Hahwah, New Jersey (1997).

Corning, Gerald, *Supersonic and Subsonic, CTOL and VTOL, Airplane Design,* College Park, Maryland, published by author, 1977.

Mackey, Dr. William F., *"Conducting a Technology Management Assessment,"* INCOSE Proceedings, 1996.

Petersen, T. J. and Sutcliffe, P. L., *"Systems Engineering as Applied to the Boeing 777,"* AIAA 1992 Aerospace Design Conference, Irvine, California, 1992.

Software Considerations in Airborne Systems and Equipment Certification, RTCA/DO-178B, RTCA, Inc., 1 December 1992.

■ **Scott Jackson, MS, MA** *is a Senior Specialist in System Engineering at the Airlift and Tankers Division of Boeing in Long Beach, California. Mr. Jackson's book,* ***Systems Engineering for Commercial Aircraft*** *(on which this article was based) was published by Ashgate Publishing Limited in 1997 (http://www.ashgate.com).*

Systems Engineering in the Telecommunications Domain

Thomas Bagg, tom.bagg@gsfc.nasa.gov

Telecommunications Industry Overview. The American Heritage Dictionary of the English Language, Houghton Mifflin Company, Boston, 1981, defines Telecommunication as: *The science and technology of communication by electronic transmission of impulses, as by telegraphy, cable, telephony, radio, or television.*

The communications industry is a core infrastructure application domain of the world economy. A wide variety of established services and rapid development of new services based on emerging technology characterize it. Although we are highly dependent on the communications application domain, we often take it for granted. Yet from an engineering viewpoint, the performance, reliability, cost effectiveness, and range of services offered is truly remarkable.

A useful classification of telecommunications services includes the following broad classes:

- Radio frequency (RF) broadcast
- Beamed networks
- Switched networks
- Hybrid systems

Radio Frequency Broadcast. RF broadcast methods are well established and used for many purposes. Broadcasts vary greatly in range depending on power and frequency. Ground wave propagation coverage extends from the deliberately limited range of a local AM broadcast station to the worldwide coverage of an ELF station supporting ballistic missile submarines.

Commercial broadcast entertainment networks (e.g., AM, FM, TV, satellite TV) are ubiquitous. RF broadcasts also support many commercial enterprises (e.g., aircraft, ships, pagers, taxicabs and onsite repair dispatch services), emergency and public services (e.g., police, fire, ambulance communications), science support (e.g., NASA's Deep Space Network), to name a few. RF broadcasts are essential to the military in peacetime coordination, as well as for tactical and strategic coordination during wartime. The safety and convenience of many persons are enhanced by use of citizen band (CB) radio. Although noncommercial, the activity of amateur radio operators in many bands and modes (e.g., radio telephones, networking, TV, AM, FM, single sideband, satellite links) has been extremely important in developing and establishing emerging technologies.

Beamed Networks. For many years, beamed microwaves were used to implement high-capacity, cross-country telephone links. Although many of these links have been replaced by fiber-optic and satellite communication links, the technology remains very useful for implementing line-of-sight links (e.g., between studios and transmitter sites; networks among local but separated enterprise locations, such as state police or forest ranger stations). Infrared laser technology also is used for short links (e.g., digital equipment distributed in various buildings), but may become unreliable in some weather conditions.

A beamed network broadcast method that may become more important is satellite-to-ground transmission with a well-defined footprint.

Switched Networks. Switched networks (typically telephone networks) currently in use depend on buried copper, microwave links, fiber optic networks, and commercial satellite links to provide both analog and digital communications. The link between some telephone instruments and the local exchange may depend on copper wires carrying analog signals for many years, although recent trends may change market forces. For reasons of capacity, cost-effectiveness, and signal quality, common carriers are rapidly converting trunk circuits in the U.S. and oceanic cables to optical fiber links carrying digital signals. For long hauls to remote areas (e.g., some international calls) the use of digital links via commercial satellites is cost-effective. The Integrated Switched Digital Network (ISDN) provides high-speed switched digital communications links in areas where it is available.

Common carriers also provide leased line services that share links used by switched networks. Based on leased lines and satellite links (commercially leased or privately owned), it is possible to establish reliable high-speed communications among any desired locations on Earth (and as demonstrated by NASA, well beyond).

Hybrid Systems. Three hybrid systems based on emerging technology have become particularly important:

- Cellular telephone services
- Cable TV services
- Internet (and similar) networks

Cellular telephone systems have been available in metropolitan areas and heavily populated corridors for some years. A combination of limited-range broadcast stations, the telephone network and computer technology permit access to telephone services from automobiles and aircraft. In the existing system, the coverage for portable instruments is limited to cells served by fixed-radio transmitter/receiver facilities that provide links to the telephone system. Several systems now under development (e.g., IRIDIUM) will provide worldwide coverage by using overlapping, moving cells served by a network of several hundred satellites.

The forerunner of the cable TV industry was based on rebroadcasting TV signals from high terrain to locations remote or shielded from the main transmitter. (This technique is still in use in some areas for both TV and radio signals.) Problems with spectrum crowding led to broadband cable systems. The industry is now moving toward fiber optics that connect users to both national cable TV networks and local broadcast stations.

The immense capacity of fiber-optic links is motivating development of interactive cable TV functions not previously available. For example, a demonstration project that is well underway permits cable TV subscribers to access the Internet at high date rates via their cable hookup. Telephone operating companies are eager to enter the cable TV and interactive applications market. Based on recent legislative debate, competition may open soon between telephone operating companies and cable TV operations.

The Internet is based on a network backbone funded by the National Science Foundation, volunteer technical and administrative support services, and links and servers provided at their own expense by network users. The open information-sharing paradigm implemented by the Internet is seen as a major resource by some and a menace to the young by others. Although the Internet as it stands is an important asset for many persons, issues with its development continue. Current issues include:

- appropriate uses of the Internet for commercial purposes (e.g., advertisements, placing orders),
- legal liability for information posted to or transmitted via the Internet (e.g., since the Bern Convention, copyright protection has been greatly extended),
- use of the Internet to support illegal activities (e.g., child pornography, narcotics traffic), and
- user information security (e.g., use of unauthorized encryption algorithms).

As these issues are resolved, the nature of the Internet will evolve. It does seem clear that the modes of information transfer and exchange are undergoing an important evolution at this time.

■ Systems Engineering Applications in Telecommunications

More and more telecommunications systems are evolving to the hybrid model. The traditional application of systems engineering becomes more important in order to address the added complexity of new interfaces between multiple classical services.

As the World Wide Web becomes more popular, new ways of marketing products are evolving. For example, authors used to have to go through various publishing firms to find one that would release a book on the open market place. Now individuals can publish their own books to the open marketplace, bypassing the publishing companies. With this change in process, publishing companies are scrambling to offer more varied and valuable services to the public. This type of change has a dramatic impact on doing business as usual.

Already, thousands of developers are building products on top of other vendor products. The Internet becomes an application development platform: everything that can run on a computer can run on the Internet. Applications, such as financial reporting, that use visually exciting graphics or catchy, need-to-know information will move toward this type of medium, because it is cross-platform, open-standard, worldwide, and inexpensive. By the turn of the century, more than half of the homes in the U.S. will be equipped with such products. With this kind of capability and new machines at lower prices, home computers will make television or telephones seem passé.

■ Systems Engineering Challenges in Telecommunications

There are a number of socio-political and technical systems engineering challenges within the telecommunications application domain. The international nature of telecommunications imposes an additional dimension to these challenges.

The challenge of properly using the physically limited broadcast spectrum and synchronous orbit slots will not disappear. The good news is that the bandwidth of fiber-optic links is extremely high, and the number of available links is growing rapidly. It is clear that emerging technology is providing vastly increased capacity for information transfer as the need arises.

Various nations and individuals view socio-political problems related to information exchange in a free society quite differently. The challenge to systems engineering is to suggest solutions and tradeoffs that preserve benefits of free information exchange while discouraging activities that are harmful to society. The idea that only encryption schemes that can be broken by government agencies should be allowed on the Internet provides one answer to detecting illegal information exchange.

The "V-chip," proposed as a means of allowing parents to control viewing of violent or explicit material on television, suggests a possible approach for the Internet that is less draconian than direct monitoring by federal agencies. Finally, there are those who propose total freedom of information exchange. There is no consensus for resolving the immediate issues, and debate will surely continue as other issues arise.

■ Telecommunications Working Group

The Telecommunications Working Group was formed several years ago in the Chesapeake Chapter. An initial charter was developed and several products were defined.

Charter: Facilitate the application of systems engineering principles to telecommunications applications, networks, and equipment; to the interpretation of these three elements;

continued on page 14

Systems Engineering in a Facility Environment

Pat Sweeney, Sweeney@edge.net

The use of the systems engineering process has received a great deal of attention in the development of large, complex systems. There are numerous companies who are considered systems engineering leaders. These companies are able to convert the needs of their customers into requirements and then products with great efficiency.

It is difficult, therefore, to understand why these same companies do not turn their renowned expertise inward for their own benefit.

Many companies seldom implement a good systems engineering process in their plants and shops. The managers of the plants or shops are operating on a tight budget, much tighter than their co-workers on the research and development side of the house.

During the 1997 INCOSE Winter Workshop in Las Vegas, the Facilities Systems Engineering Working Group accepted the challenge to develop a model that would demonstrate why SE was needed in a facility environment. *Figure 1* is a model of the process the FSEWG produced. This figure represents the typical functions performed in a facility environment and their relationships to the SE Process.

Let us look at each process identified in this model. (As each process is discussed, refer back to Figure 1.)

The first process is the relationship between Operations and Systems Engineering. Some inputs are required from the operations community in order for the Systems Engineering process to work. These inputs include: information incorporating operational improvements, request for new missions, notification of changed environments and constraints and a constant input of operational data. The Systems Engineering process, in return, will provide the facility with balanced operational decisions by providing a basis to develop metrics.

Inputs are also required from maintenance in order to take full advantage of the systems engineering process. One such input is data on equipment reliability.

Information on equipment reliability data. This data is obtained on configuration items (CI) through configuration management input and capture, and machine diagnostics data. The SE process will be able to provide revised requirements and criteria to assist in developing predictive and preventive maintenance plans. The process will also provide information used to develop failure modes and perform failure analyses.

The inputs to the SE process from the design and construction communities include trade studies, engineering solutions and configuration management data capture. The SE Process will allow these inputs to be converted into revised requirements and criteria to support balanced problem solving solutions.

The SE Process receives revised requirements from the Demolition and Disposal Process. These revised requirements are reviewed in the SE process. The SE Process will provide information such as identification of any hazardous material or any interfaces with other systems being affected by the demolition or disposal of the subject system.

The inputs to the SE Process from the License/Certification process are changing requirements. There are always requirement changes passed down in the areas of safety and environmental compliances. These changes are fed into the SE Process and as a result the process provides balanced problem solutions, demonstrating compliance to the new requirements.

The model we have just briefly reviewed is still in its infancy. The Facilities Working Group is in the process of refining and further defining these processes. The Facilities Working Group is positive that a detailed model of these interactions will greatly assist the Systems Engineering community in its quest to expand the use of SE beyond the traditional research and development applications. If anyone has any suggestions or comments on this model or wishes to join the Facilities Working Group, please contact either: Patrick Sweeney, Sweeney@edge.net, (931) 454-4709, or Bill Henderson, (931) 454-5295.

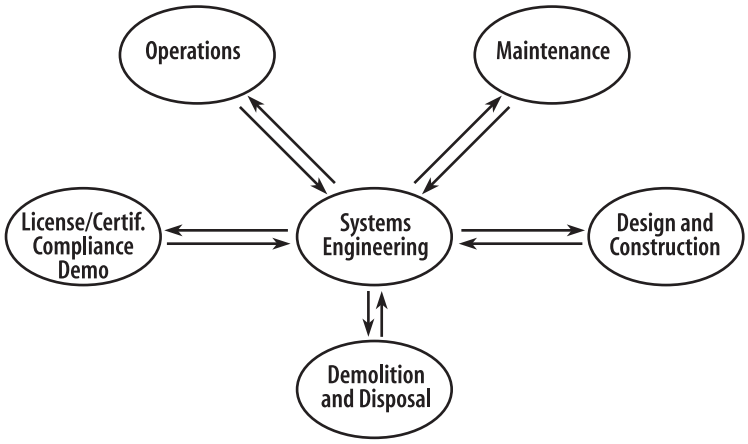

Figure 1. SE Application in a Facility Environment

continued on page 14

Systems Engineering Application Profiles (SEAP)

Mark Austin, austin@isr.umd.edu

History. The concept of INCOSE technical activities in systems engineering applications started at the 1992 Symposium in Seattle, with the creation of a Commercial Applications Working Group led by Randy Iliff. A separate Resource Management Working Group was started at the same time by Fred Martin. Early discussions centered on the different industry segments and applications areas where systems engineering (in many cases under a different name) was being successfully practiced. The importance of not simply transferring the DOD model of systems engineering to other applications areas was stressed. The various interest groups decided in 1993 to meet as a single body under the Emerging Applications Technical Committee. Bob Coyne became chairperson of the group at the 1993 Symposium. Rich Mintz volunteered to facilitate the groups efforts for 1994. The group merged onto the information highway in April 1994 with the first distribution of its monthly activity report by e-mail. At the January 1995 annual business meeting, William Mackey agreed to create the first draft of the Emerging Applications White Paper and to direct the Emerging Applications Working Group (EAWG) efforts in the near term. The EAWG approved its charter, set goals for 1995-96, and released the Emerging Applications White Paper at the July 1995 Symposium. At that symposium, William Mackey was elected to a two-year term as Chairperson.

At the January 1996 annual business meeting the name of the working group was changed to the Applications Forum Working Group and the charter was modified. The "Systems Engineering Application Profiles, Version 1.0," was completed in May 1996 and published in the 1996 Symposium Proceedings, Volume 2.

During 1997, William Mackey became Chairman of the SE Applications Technical Committee (SEATC), and I agreed to become Chairman of the Applications Forum Working Group (AFWG). As a Professor at the University of Maryland, I have elected to use the Systems Engineering Applications Profiles (SEAP) as the basis for a web page prototype. I expect to evolve the INCOSE SEAP in a way that traditional documents cannot grow (refer to the section on the Web-based SEAP below). Meanwhile, updates to the SEAP document have been made on a periodic basis and a full release is expected to be in the CD-ROM produced for this year's symposium in Vancouver. Look for it!

■ Structure Of The Systems Engineering Applications Profiles.

The purpose of the SEAP is to introduce the technical activities of INCOSE and the SEATC, introduce the current state of systems engineering in a broad spectrum of applications, and propose future directions for INCOSE's role in promoting the discipline of systems engineering to a wide range of application domains.

This document benefits all organizations interested in the discipline and practice of systems engineering. It also offers the opportunity for technology transfer across application domains. This document will continually mature and provide a documented forum for the primary systems engineering issues in each application domain.

Version 1 of the document has five chapters and five appendices:

- Chapter 1 introduces the INCOSE and its technical board, technical committees, and supporting groups.
- Chapter 2 introduces INCOSE's AFWG.
- Chapter 3 provides an overview of systems engineering applications.
- Chapter 4 discusses systems engineering applications in multiple industry application domains.
- Chapter 5 proposes future directions for the systems engineering applications area of INCOSE.
- Appendix A lists INCOSE's working groups and working group contacts.
- Appendix B contains the charter of the AFWG.
- Appendix C contains the goals of the AFWG.
- Appendix D lists current AFWG members.
- Appendix E contains the Author's Writing Guide.

A systems engineering application domain is broadly defined here as a sphere of influence or activity to which the systems engineering interdisciplinary approach is applied, to create systems and solutions within the domain. The profiles are written by different experts available to the INCOSE SEATC. The common structure for each profile is as follows:

4.X Application Domain

The application domains are listed alphabetically in the table below. Those application domains with section numbers are included in this document. Other application domains will be added in future versions.

4.X.1 Introduction

A brief summary of the application domains (e.g., agriculture, highway transportation) introduces the subject matter. Two tables summarize the industry companies or domain participants and the systems engineering activities.

continued on following page

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4.X.2 Industry Functions and Processes
Shows how domains are decomposed into individual functions and processes that represent the primary activities of the industry or application domain. For example, highway transportation systems is decomposed into topographical coordination and requirements, corridor study and design, preliminary design, and detailed design.

4.X.3 Technology Profiles
Selected technologies that can benefit the application domain are discussed. For example, highway transportation systems focus on the automation processes of computer-aided drafting and design, software applications, and highway design automation steps.

4.X.4 Systems Engineering Challenges
The primary challenges that could be met by using systems engineering are discussed. For example, in the Highway Transportation Systems section, the Intelligent Vehicle Highway System (IVHS) or Intelligent Transportation System (ITS) and technology challenges are discussed.

4.X.5 Contacts
The author, INCOSE contacts, and industry contacts are listed.

4.X.6 References
Citations from INCOSE presentations and papers, the general literature, and other key sources are listed.

Each section follows the above outline but in some cases adapts the structure to fit the application domain. The sophistication of each section in this document also varies. Note that 17 of the application domains have material, while 9 more are yet to be developed. This is where you come in. If you would like to contribute to an existing application domain or create a new domain, please contact either of the two following people: **William F. Mackey**, SEATC Chair, 301-794-1966, wmackey@cscmail.csc.com, or **Mark Austin**, AFWG Chair, 301-405-6627, austin@isr.umd.edu.

■ Web-Based Systems Engineering Applications Profiles

The INCOSE Applications Forum Working Group has published Version 1 of its Systems Engineering Applications Profiles (SEAP) in traditional report format. Version 2 of the SEAPs document will be part of the CD-ROM released at this year's upcoming symposium in Vancouver.

At the Institute for Systems Research, University of Maryland at College Park, we are experimenting with the idea of creating Web-based Systems Engineering Applications Profiles and integrating them into the curriculum for Master of Science in Systems Engineering (MSSE) program. Our MSSE program focuses on the technical aspects of decision making in systems engineering, and places much less emphasis on project management than some of our contemporary institutions. Our student population is evenly divided between recent graduates from traditional engineering departments and professional engineers who are working full-time while they pursue an MSSE degree, usually at the pace of one course per semester.

During the 1997 Fall Semester offering of ENSE 623: Systems Engineering Design Projects, six groups of students jointly developed a first-cut implementation of the web-based SEAPs. See http://www.isr.umd.edu/~austin/ense623.html.

Each group was instructed to follow the SEAP format proposed by INCOSE. The only major addition to the format was a section on Systems Analysis, where the students were asked to demonstrate how analytical procedures they learned in the prerequisite courses (Systems Engineering Principles and System Modeling and Analysis) could be applied to a decision making scenario within their application domain of choice. We also provided the students with a small set of Java Applet programs (i.e., a spreadsheet program; bar charts; pie charts) for the interactive presentation of systems ideas. Finally, the students were strongly encouraged to arrange interviews with systems engineering professionals, and to critically examine what they were told worked in practice versus what they may have learned in school.

Whereas the traditional report

Table 1. Systems Engineering Application Domains

SE Application Domain	Section Number	SE Application Domain	Section Number
Agriculture	4.1	Housing and Building Systems	
Commercial Aircraft	4.2	Information Systems	4.11
Commercial Avionics	4.3	Manufacturing	4.12
Criminal Justice System and Legal Processes	4.4	Medical Devices	4.13
Drug Abuse Prevention		Motor Vehicles	4.14
Emergency Services		Natural Resources Management	4.15
Energy	4.5	Political and Bureaucratic Interfaces	
Environmental Restoration	4.6	Services Industries	
Facilities	4.7	Space Exploration	4.16
Food Services		Telecommunications	4.17
Geographical Information Systems	4.8	Transportation	
Health Care	4.9	Urban Planning	
Highway Transportation Systems	4.10	Waste Management and Disposal	

format provides a bounded, linear presentation of the SEAPs, web-based SEAPs offer dynamic real-time information presented in a multidimensional space of multimedia. Readers navigate this space by clicking on the appropriate links. For the most part, the students had little problem learning the HyperText Markup Language (HTML) and in presenting their projects in the required format. Some of the questions in the SEAP Requirements Document were hard, and the students were warned that depending on the nature of their application domain, finding answers to some of the profile questions may be impossible. (Needless to say, of course, the warning didn't stop some groups from trying!)

The collection of the class's Systems Engineering Applications Profiles have been organized into a matrix presentation format. Each row of the matrix contains cells with hypertext links to the main sections within each profile (e.g., functions and processes; systems engineering challenges). Each column of the matrix contains links to a particular aspect of systems engineering (e.g., systems analysis) as it applies to multiple domains. Since more than 50 matrix cells will fit on a single navigation page, the matrix style of SEAP presentation provides a very efficient way of hopping among projects and comparing systems engineering procedures across disciplines.

■ Benefits of On-Line Applications Profiles

In this section, I offer some thoughts on how I think web-based SEAPs should evolve so that they are mutually beneficial to educational institutions and INCOSE professionals alike:

Benefits to Education. Faculty at the University of Maryland, like those at most tertiary educational institutions, are currently very interested in figuring out how the web can be used to enhance our teaching and research activities. It is known to everyone involved that the web is a great tool for information delivery—class web pages containing homework assignments, answers to frequently-asked-questions, class announcements, and controlled access to course notes are now scattered across the Internet. Students and teachers have gravitated towards this mechanism of information delivery because of the convenience and time-efficiency it affords. Whether a student learns more because of the web is entirely another matter.

Research in education indicates that information is only learned or understood when students transform it into knowledge. This transformational process involves decoding of the information, looking at it from several points of view, and constructing meaning from it in terms of what a student already knows. In many cases, learning something amounts to transforming information fragments into well defined internal representations or models. Useful models tend to be both abstract, in the sense of applying to a number of cases, and complete. An engineer should be able to look a model for guidance on what information is needed to implement a specific case.

Much of the criticism of higher education in recent years has arisen from concerns about the relevance of what students learn. Academics often make a strong case for teaching abstractions and general ideas that are context free, and simply assume a student will be able to figure out how this knowledge can be used in a number of specific application areas. This is how linear algebra and calculus are often taught, for example. However, when students fail to see the connection between what they have learned in school, perhaps in a class on systems engineering analysis and modeling, and its application to real world problems much of the benefit in learning the material is essentially lost.

In the MSSE program we are excited about web-based SEAPs because of the potential they hold for strengthening the connection between abstract systems ideas and the range of contexts in which knowledge can be applied across a variety of disciplines. When students are delving into a new and most likely unfamiliar application area, an application profile format that is common across application domains is very useful. We hope that future SEAPs will expand on the current format and contain links to on-line case studies of successful systems engineering projects. One way that students learn about cause and effect relationships within a discipline is through the use of simulation programs. We hope that future SEAPs will contain Java-based interactive web pages and down-loadable simulation programs, perhaps demonstrating how systems analysis techniques can be applied to decision making across a variety of application areas. And finally, we hope that the SEAPs will provide an avenue for students to get in touch with practicing members of the systems engineering profession.

Benefits to INCOSE Members. For INCOSE perhaps the most compelling short-term reason for moving towards web-based SEAPs is the opportunity it affords for increased promotion and readership of INCOSE's activities. The number of systems engineers who might visit a well-designed web site with information rich profiles simply dwarfs the number of readers of a hardcopy document. The second benefit of web-based SEAPs is the ease with which a team of geographically dispersed individuals can jointly participate in the writing of a new application profile.

Of course systems engineering education is a life-long endeavor, and so many of the benefits of SEAPs to INCOSE members are just the same as those to educational institutions. The SEAPs at the University of Maryland should be regarded as a testbed for exploring new ways to connect "classroom material" to systems engineering practice. The web-based SEAP format

continued on following page

SEAP: *continued from previous page*

should be periodically updated to reflect the best of these ideas and advances in web technology.

■ **Mark Austin** *is an Associate Professor at the University of Maryland, College Park, Maryland. Mark holds joint appointments in the Department of Civil Engineering and Institute for Systems Research (ISR). Mark is the Graduate Director for the Master of Science in Systems Engineering Program at ISR, and is currently chair of the INCOSE Applications Forum Working Group. He can be contacted at austin@isr.umd.edu.*

Facility Environment: *continued from p. 10*

■ **Patrick Sweeney** *is currently the Configuration Management Specialist for Sverdrup Technology. He has experience in every part of the life cycle of major systems with detailed experience in operations and maintenance. He is a 1979 Graduate of the United States Military Academy at West Point.*

Telecommunications: *continued from p. 9*

and to the dissemination of related lessons learned.

Purpose: To be a forum for transfer of information and ideas relating to telecommunications technology and processes.

Very little work was done, and this spring I was asked to revive this working group. To this end, I see several goals worth pursuing:

- Telecommunications and Information Systems Applications session at the Vancouver Symposium (4 papers accepted)
- Coordination among existing INCOSE activities
- Virtual attendance at meetings and symposia
- SE and the Internet
- Information sharing between systems engineers in the telecommunications industry
- Glossary of telecommunications terms
- Other areas of interest to the members

I feel this activity can be worthwhile, but it will only happen if several people step in to make it work. If you are interested in being a co-chair or participating at any level, please contact me by email or by calling 301-809-2218.

■ **Tom Bagg** *has experience in every part of the life cycle of major systems including requirements analysis, software development, test, installation, and operations. He currently supports systems engineering at NASA Goddard Space Flight Center.*

President's Corner

Bill Schoening, schoening@inlink.com

I continue to be surprised and pleased with the progress we have made as an organization over the past six years. I am especially amazed when I recall that we started from scratch with just a few hundred members. Our membership is over ten times what it was in when I first joined INCOSE, and we have chapters in Europe, Canada, and Australia, as well as all over the U. S.

As president, I am pleased our technical products continue to grow in number and maturity. The new standards for systems engineering and for a maturity model, EIA-632 and EIA-731, are progressing through the review and approval process. (These products are joint efforts between INCOSE and EIA.) ***INSIGHT*** is back on track and you have received the first edition of our journal, *Systems Engineering,* that will be published on a regular basis. In addition, the long-awaited *Systems Engineering Handbook* is now available.

These products do not come easily; the help of many INCOSE members is needed to make them happen. The more members who actively participate on the technical and administrative committees, the more the workload is spread out so that goals are readily achievable. Participation on INCOSE working groups will keep you up to speed with the latest INCOSE development. Many participants are sought out by their home organizations as the local experts in systems engineering. In addition, you can work shoulder-to-shoulder with some of the best minds in INCOSE.

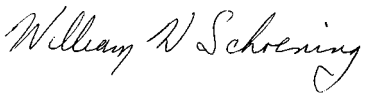
As INCOSE matures as an organization, leaders must be developed from within the organization rather than relying solely on those with previous experience elsewhere. By participating in INCOSE's committees and working groups you can practice and develop your own leadership skills away from the office, and help INCOSE at the same time. As an example, INCOSE is starting a Planning and Budget committee to support the Treasurer and develop the expertise in future treasurers. I expect that all future nominees for Treasurer will have had experience in this committee. So, if you have aspirations for being a future INCOSE Treasurer, contact me (314-234-9651), Pat Hale (860-676-5250), or Ken Ptack (703-413-1087) about joining this committee.

Our Corporate Advisory Board (CAB) continues to grow. Dornier Satellitensysteme GmbH, a division of Daimler-Benz in Germany, has become our newest member. Dornier becomes our second CAB member based outside North America, following GEC Marconi. This is a significant step toward making INCOSE truly international in scope. I am delighted that Dornier has joined us, and am looking forward to their guidance as a member of our CAB.

I had the good fortune to attend a meeting of the German chapter in Munich on May 7 with 150 other systems engineers. This was a special meeting with a reception hosted by BMW. Speakers from BMW, Siemens, and Dornier described the SE activities at their respective companies. Bernard Thome, chairman of the chapter, discussed the chapter's accomplishments during the past year and the objectives for the future. Ginny Lentz, Carol Gutierrez, and Mary Simpson — all CAB representatives for their respective companies — joined me in representing the INCOSE central organization at this event. In addition, Allen Fairbairn from the UK chapter made the journey to Munich. The reception that followed gave us an opportunity to visit with many individual systems engineers to find out about their successes and struggles or just get acquainted. (See The Founding Reception of the German Chapter on page 26.)

The SE leaders at Dornier gave up almost an entire day to show us what they are doing and discuss opportunities for the future. It was an excellent interchange of ideas for all of us. Some hold strong opinions about tools and requirements. (Before electronic tools, we concentrated on the content; now we play with the format.) I think you will enjoy meeting and working with them at future symposia and workshops.

So where do we stand midway into 1998? We are making significant strides with our products for members as well as with our international development. INCOSE is striving for more member involvement in its activities. Lastly, the 1998 International Symposium in Vancouver promises to be an outstanding event. I look forward to seeing as many of you as possible there in July.



Working Groups

Measurement Working Group Continues to Count

Garry Roedler, Chair,Measurement WG, garry.j.roedler@lmco.com

The Measurement Working Group (MWG) has continued to be effective during the past quarter. The MWG now has two approved INCOSE products and is working on six ongoing projects.

■ Status of Ongoing Projects

The MWG completed and obtained approval of the INCOSE Systems Engineering Measurement Primer. In March, the Technical Board approved the Primer as an INCOSE Technical Paper. (See the article on page 19 for information regarding content and availability.)

The Practical Systems Measurement (PSysM) project has continued to make progress. A project planning meeting was held in mid-March and the PSysM Integrated Product Team (IPT) has held two meetings since the INCOSE International Workshop (3/31/98 and 5/21/98). To date, the PSysM IPT has identified a candidate set of common issues for systems projects, as well as a candidate set of measures that address those issues. The IPT is currently working on defining the issues and measures that have met the selection criteria for inclusion in the guidance products. The IPT goal is to review and refine definitions at the PSM Users Group Conference July 20-23 and at the MWG meetings at the INCOSE Summer Symposium. The MWG POCs for this project are Garry Roedler (Lockheed Martin) and Bill Farr (Naval Surface Warfare Center).

The Metrics Information Systems Tools (MIST) continues to be updated with the enhancement requests that were prioritized during the International Workshop. MIST is still scheduled for release late this summer. The MWG POC for this project is Bill Farr.

The MWG has been working towards defining the requirements for measurement tools. These requirements will be provided to the Tools Data Base WG for provision to tool vendors in the form of a survey later this year. A draft plan for the requirements definition is currently under review by the MWG and the requirements definition has already been started. The requirements will be reviewed at the MWG summer meeting and should be completed by the fall meeting. The MWG POCs for this project are Chris Miller (Lockheed Martin) and Peter Baxter (Distributive Data Systems).

The MWG has an ongoing project to compile Frequently Asked Questions (FAQs) and develop appropriate responses. Two of these are published in each INCOSE ***INSIGHT*** publication. The composite set of these FAQs is under review by the MWG and will soon be available through the MWG web page. The MWG POC for this project is Ken Stranc (TASC).

A new MWG web page is currently under development. The new web page will allow the INCOSE member to download various MWG products, status, working documents, and technical papers, in addition to links to valuable measurement related sites. A draft page has been completed by Peter Baxter and is under review by the MWG. The new page will be put in place after the symposium.

■ Upcoming MWG Related Events

The MWG plans to conduct two meetings during the week of the INCOSE Symposium; on Monday, July 27 from 9:00 AM until 5:00PM and on Thursday, July 30 from 1:30 PM until 3:00 PM. In addition to the Symposium, the Practical Systems Measurement IPT, which is supported by the MWG, will be conducting a workshop at the PSM Users Group Conference in Breckenridge, CO. The PSM Users Group Conference will be held from July 20 – 23.

■ Measurement to be theme for Upcoming *INSIGHT*

The MWG has agreed to provide a set of measurement related articles towards creating a measurement theme for the Winter issue of INCOSE ***INSIGHT***. The MWG is currently working towards selection of topics and articles. A list of the articles will be provided in the next issue.

In addition to the INCOSE ***INSIGHT*** articles, the MWG has been requested to provide an article to the Army Insight publication on metrics. Details are currently being reviewed.

■ Other Measurement News

Some of the INCOSE MWG members will be attending the Practical Software Measurement (PSM) *Train-The-Trainers* session in June. After completion of this course, they will be qualified trainers for PSM and the associated measurement tool called INSIGHT. These MWG members include Garry Roedler (Lockheed Martin), Chris Miller (Lockheed Martin), and Don Gantzer (TRW). Bill Farr (Naval Surface Warfare Center) will be attending the next training session.

■ MWG Technical Products and Services

Finally, the INCOSE Technical Products and Services Plan has been updated to reflect the MWG's current set of available, in-progress, and planned products and services. This plan can be accessed through the INCOSE web site if you would like to understand the MWG's products and services.

For further information regarding the INCOSE Measurement Working Group, contact:

Garry Roedler (Chair), (610) 531-7845, garry.j.roedler@lmco.com
Jeanmarie MacLean (Co-chair), (978) 858-4927, Jeanmarie_Maclean@res.raytheon.com
Patrick Antony (Co-chair), (562) 922-3697, patrick.r.antony@boeing.com

Measurement: Frequently Asked Questions

Ken Stranc, kjstranc@tasc.com

Question: I have been tasked to start a measurement process for my program. Where do I begin?

Response: You begin by first acquiring some background knowledge in measurement and then, most importantly, by describing the problem, or the operational need that the measurements process is intended to address. Once you have done this you will be prepared to develop a Measurement Plan, and finally to initiate your measurement process.

Acquiring the knowledge needed to start a measurement process for your program is not difficult. The *INCOSE Systems Engineering Measurement Primer* is an excellent starting point. It provides a tutorial on measurement that includes a concise overview of the steps you should take to begin measurement work on a project. The annotated list of references found in the primer is a valuable resource for beginners and seasoned measurement practitioners alike. Use this list to find information sources that describe specific measurement topics of interest to you.

The next step to take is to define the problems or operational needs that the measurement process will address. Start by developing a complete understanding of the goals of your project. Identify your project's constraints, anticipated problems, and areas of uncertainty. Be sure to identify your project's stakeholders and their interests as well. Keeping all these concerns in mind, develop a set of questions whose quantitative answers provide sufficient insight into the project issues. Then, select measures that will provide the required quantitative information.

Before moving on, it is essential that you review and refine the goals, issues, questions, and selected measures with the project's stakeholders. This step ensures their buy-in to the measurement process. In fact, it is always a good idea to review the measurement process with your stakeholders from time to time as the project evolves. This keeps the measurement process responsive to stakeholder needs.

There are currently two popular methods for selecting specific measures based upon examination of a project's goals. The first method, described in *Practical Software Measurement: A Guide to Objective Program Insight* [http://www.psmsc.com/psm_doc.html], is applicable to systems measurement as well as to software measurement. It begins by enumerating a set of common project issues, such as schedule and progress, resources and cost, and product quality. Select from the issues of greatest importance to your project and then proceed to develop detailed questions. A second very similar method for selecting measures is called the Goal/Question/Metric (GQM) approach. Using GQM, you begin by stating the overall goal of the stakeholders for the project and then identify several supporting subgoals. Then, proceed by defining questions whose answers unambiguously indicate whether the goals are being achieved.

Use your Measurement Plan to capture all the information that you and your project team need to know to carry out the measurement process. State the goals and objectives of the measurement process as they were developed in the preceding paragraphs. Define the roles and responsibilities of everyone very explicitly with respect to measurement, and develop the schedule for performing measurement activities. List the resources available. Include in the Measurement Plan a detailed description of the measurement information you expect to collect, including the procedures for collecting the data, aggregating the data, analyzing the data, and reporting the results. Finally, describe how measurement results will be used as input to drive process/product improvement activities. This includes explanations of the actions that are expected when measurement results fall outside of the limits you set.

After you have selected the measures and have written the Measurement Plan, initiate the measurement activity by reviewing the plan with the project staff. This includes making specific assignments, acquiring tools to facilitate the measurement effort, establishing schedules, and setting up data repositories.

Question: How much will implementing a measurement process impact my project?

Response: It is not possible to give a blanket answer to this question or even to cite a rule of thumb since every project's measurement process is motivated by different issues and is implemented in a different way. Resolution of issues that are driving the measurement process has a value that is determined by the organization conducting the project in light of the goals that organization is attempting to achieve. So when a measurement process contributes to the successful resolution of critical project issues and the achievement of an organization's goals, it has a positive impact whose value is directly related to the value of achieving those goals.

There is no question that implementation of a measurement process comes with negative impacts as well as positive ones. The key is to ensure that the benefits of the measurement process far outweigh the perceived tangible and intangible costs. Negative impacts to consider include resource costs such as labor, tools, and computers, as well as intangible effects such as disruption of a person's work rhythm in order to record data.

There are steps you can take to minimize the negative impacts of a measurement process. Look for measures that minimize the data collection, data aggregation, and analysis efforts. Use these as criteria in selecting measures. The procedures used to collect, aggregate, analyze and report measurement information should be reviewed periodically to identify changes that will lead to greater efficiency. Special consideration should be given to measures for which data can be collected, aggregated, and reported through auto-

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mated means. Most definitely, the measurement process should be reviewed periodically to eliminate measures that no longer serve a purpose.

Resource Management Interest Group

Ted Dolton, alanjoanne@aol.com

The RMIG is an Interest Group of the INCOSE Systems Engineering Applications Technical Committee. The INCOSE San Francisco Bay Area Chapter is currently the focal point of the RMIG; however, participation is invited from anywhere within INCOSE.

The RMIG works to find new applications areas for Systems Engineering in public sector domains that conserve, help understand, and manage resources, both natural and human. The RMIG works with jurisdictions and citizen groups, on local, state or national levels, in understanding their requirements and issues, and helps them utilize Systems Engineering processes in meeting their goals.

In the past, RMIG has done a variety of projects: developing a specification for a new school for hearing-impaired children; working with the U.S. Forest Service on wilderness management, and working with local groups in the San Francisco Bay Area on watershed management. Current projects include working with the following organizations: a non-profit agency in East Palo Alto in creating a systems approach to developing affordable housing; the San Francisquito Creek Comprehensive Resources Management Plan (CRMP) Group in facilitating creation of a multi-jurisdictional agency to manage the watershed; and the Department of Energy in using Systems Engineering tools to create nuclear waste management systems that include public acceptance in addition to the technical system.

Key lessons learned in working with these organizations are:

1. the need to identify and engage stakeholders;
2. use of systems process to address stakeholder interests and integrate them with the solution-discovery process;
3. recognition that there are language/lexicon differences between systems engineers and people in resource/civic and non-governmental organizations;
4. getting customers to understand that systems need a unique approach;
5. introducing SE gently, sometimes invisibly;
6. complementing a customer's system; and
7. not letting complexity be a barrier to accomplishing the project.

Expanding on the last point, in the aerospace industry we used tools such as large schematics and functional flows. We don't pretend to "understand" in the sense of remembering all the many pieces and how they all work together, but we trust the tools and use them if we believe they were created using a trustworthy process, and applied by competent people. However, people outside our field are often not used to confronting complexity of this sort. Part of our job is to help people overcome this barrier by reassuring them that to manage a complex situation they don't have to deeply understand each element of it. We need to show them how SE tools can help them manage the system and become comfortable with seemingly overwhelming complexity.

In the affordable housing arena, we have helped the East Palo Alto Community Alliance Neighborhood Development Organization (EPA CAN DO) develop specifications for an affordable housing project, and to apply decision-making tools in a tenant selection process.

In watershed management, we are dealing with a system that involves many resource elements as well as political issues. A watershed is defined as all the land between the ridges that is drained by a particular stream and its tributaries. Watershed management is concerned with the beneficial uses of a watershed, which in general include:

1 Providing adequate water supply
2 Maintaining water quality
3 Flood and landslide risk mitigation
4 Maintaining the natural environment as a home for species and ecosystems
5 Navigation
6 Food production
7 Power production
8 Providing scenic, recreational, and educational experiences
9 Preserving property rights
10 Controlling undesirable human behavior in the watershed features (homeless camps, vandalism, crime access)

The complexity of fulfilling these objectives is compounded by the fact that watersheds do not respect the arbitrary human boundaries of jurisdictions and institutions. In fact, as humans we often choose streams or rivers as the boundaries between our political jurisdictions. This inherently sets up multi-jurisdictional issues.

The particular watershed that CRMP is addressing is the San Francisquito Creek. It is the boundary between two cities and two counties, and includes three other cities in its headwaters. This complex of interests and physical realities is a systems challenge. A plan is being created to show how the various agencies might work together to manage the watershed. This provides the opportunity for the SE contribution: one of the RMIG members is providing a SE structure while leading the creation of the plan.

Participation of any INCOSE member is welcomed. Contact Ted Dolton, 650-321-5950, or by email.

Now Available!

INCOSE Systems Engineering Measurement Primer Has Arrived!

Garry Roedler, Chair,Measurement WG, garry.j.roedler@lmco.com

In March 1998, INCOSE released its *Systems Engineering Measurement Primer* as an approved technical paper. The *SE Measurement Primer* was developed by the Measurement Working Group (MWG). The creation of the primer was led by Garry Roedler (Lockheed Martin) and Jennifer Dunn (Tellabs) and included support from the following additional authors: Dr. Donna Rhodes (Lockheed Martin), Dr. William Farr (Naval Surface Warfare Center), Cathy Tilton (National Registry, Inc), E. Richard Widmann (Raytheon), and Patrick Antony (Boeing). This is the second official INCOSE product from the MWG.

Purpose and Scope of the Primer

The INCOSE *Systems Engineering Measurement Primer* is a basic introduction to measurement for the beginning measurement practitioner in systems engineering. The Primer is organized to address two objectives. The first objective is to define the basic concepts behind measurement and measurement programs in such a way that they will be usable and readable by anyone regardless of their experience and background. The second objective is to provide the background knowledge needed to prepare you to set up a measurement program. The primer is written from the perspective of the reader who is relatively new to the terminology, concepts, and use of measurement.

■ Alignment with Other Measurement Guidance

The Primer has been written to be consistent with the leading guidance available today. The principles included here are consistent with the INCOSE Metrics Guidebook for Integrated Systems and Product Development and the Joint Logistics Commanders (JLC) Practical Software Measurement (PSM) guidebook, which are among the leading guidebooks for systems and software measurement.

■ A Walk through the Primer

Definitions and Commonly Used Terms. Commonly used measurement terminology is presented in the beginning of the Primer to provide the reader with an understanding of the basic terms used in the measurement guidance.

The Measurement Process. The Primer defines the measurement process, as shown in Figure 1. It includes the explanation of each step of the process. The process begins with the specification and selection of measures and indicators that are based on the issues, risks, and objectives of the project and system. The process description then covers the collection, computation, and analysis of data for the selected measures and indicators. Finally, the reporting and usage of the results is discussed. In addition to the description of the measurement process, the Primer provides guidance for the infrastructure to support the measurement program. This includes guidance related to the management commitment, measurement planning, resources, training, tools, and data repository.

Purposes of Measurement. It is important to understand the various purposes of measurement to assure proper measurement focus. The Primer identifies the common purposes or objectives of measurement and discusses the focus of measurement to reflect each of these, which includes Characterization, Evaluation, Prediction, and Identification.

Application Guidance and Lessons Learned. To assist the new practitioner with appropriate implementation of measurement, the Primer contrasts correct and incorrect uses of measurement, provides rules of thumb for implementation, and discusses human factors related to the measurement program.

References. Since the Primer is intended to be an introduction to measurement, the new practitioner will probably need additional information after starting to use measurement. To assist in the practitioner in finding the desired information, the Primer provides a section of references that are categorized for further information regarding specific facets of measurement.

Examples. Examples of measurement usage are provided for process, product, and project measures.

continued on following page

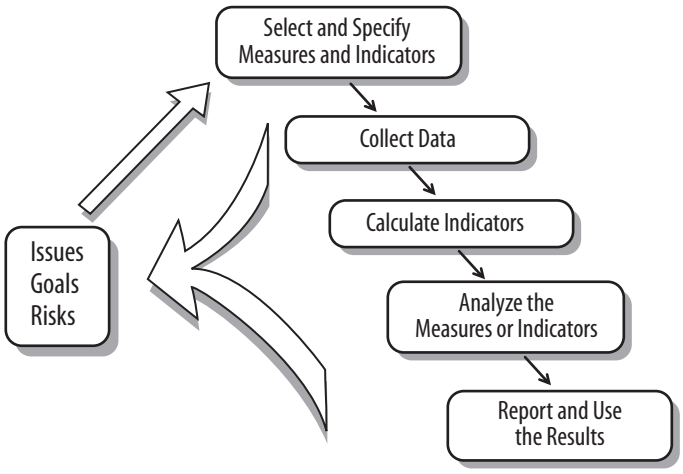

Figure 1:The Measurement Process

Now Available!

INCOSE Systems Engineering Handbook

Tim Robertson, timr@sirius.com

The *INCOSE Systems Engineering Handbook* provides a description of the key process activities performed by systems engineers. It describes in some detail the purpose for each process activity, what needs to be done, and how it can be done. The intended audience is primarily the new systems engineer, an engineer in another discipline who needs to perform some systems engineering functions, or a more-experienced systems engineer who needs a convenient reference. The intent is to provide enough information for the user to determine whether a given process activity is appropriate in supporting the business objective(s) on the program or project they support, and how to go about implementing the process activity.

The process activities which are described are applicable to most engineering projects. The appropriate resources, including manpower and schedule time, devoted to any process activity should be based on cost/benefit considerations. Anecdotal and "lessons learned" experience from some large programs indicates that serious problems were caused by insufficient systems engineering. However, systems engineering is not advocated as a universal solution to all program problems. Rather, this handbook attempts to describe the purpose and value of specific systems engineering process activities, together with some guidance to help determine when each activity is complete.

The intent of the descriptions in the handbook is to show what each systems engineering process activity entails, including the need to design for affordability as well as performance. On some projects, a given activity may be performed very informally (e.g., on the back of an envelope, or in an engineer's notebook), or very formally, with interim products under formal baseline control. The handbook does not advocate *any* level of formality as necessary or appropriate in all situations but provides helpful perspective to users.

The *INCOSE System Engineering Handbook* is not a specification of what must be done on a program, but rather a "how to" guide to perform most of the processes likely to needed on any program, government or commercial. It does discuss the current status and plans for several systems engineering specifications.

Some highlights of items covered by the handbook are:

1) Overview of systems engineering, the systems engineering process, and what systems engineers *do;*
2) How to tailor the systems engineering process to suit program needs;
3) The elements of typical government and commercial project lifecycles and the types of system engineering activities usually performed during each element;
4) Detailed descriptions of systems engineering process activities. Some examples are:
   - Defining needs, operational concept, and requirements
   - Functional analysis, decomposition, and allocation; functional requirements
   - System modeling, systems analysis, and tradeoff studies
   - System architecture synthesis and cost effectiveness analyses
   - Writing good requirements and specifications; specification trees
   - Requirements allocation, traceability, and control
   - Design constraints
   - Defining, refining, and integrating a product's physical configuration
   - Prototyping, integration, and verification
   - Systems engineering product and process control
   - Configuration and data management; technical performance measurement
   - Steps in organizing and running integrated product and process teams
   - Measuring an organization's Systems Engineering Capability
   - Risk management approaches
   - Engineering technical reviews and their purposes

5) Many useful techniques for systems engineers are covered, including:
   - Functional thread analysis involving use of stimulus-condition-response threads for specifications, development, testing, and reviews
   - Metrics and tools, such as: N-squared charts, QFD, timeline analysis, and functional flow diagrams
   - How to prepare and use activity network diagrams and professional quality project and task schedules
   - Use of the internet by systems engineers
   - An object-oriented approach to systems engineering

To obtain a copy of the Handbook, contact the Central Office. The price is $20 for members, $25 for non-members.

Measurement Primer: *continued from p. 19*

■ How to Get Your Copy

Copies of the *Systems Engineering Measurement Primer,* as well as any other INCOSE document can be obtained from the INCOSE Central Office. General information on INCOSE, the Measurement Working Group, any other INCOSE working group, or membership may also be obtained from the INCOSE Central Office or web site (see page 3).

Are you looking for training? Do you offer training?

Jack Ring, jring@amug.org

The Education and Research Technical Committee would like to help INCOSE members be more aware of commercial sources of training, education and learning environments. Accordingly, this is a call to both suppliers and consumers of such training, education and learning environments to register for this new service. Interested parties should send email to me, at the above address, for details on how to register. Please inform associates of this new service.

INCOSE is performing this service solely for the benefit of members. INCOSE will make no recommendations regarding suppliers and will seek to treat each supplier equally.

The TELET Work Group of E&R has designed a "straw-ment" lexicon to facilitate correlation of user needs with supplier offerings. Parties of either type are invited to register their needs and offerings according to the topics defined in the lexicon.

The INCOSE service will evolve as dictated by the level of interest. The current concept is to create a web-based transponder that will take input regarding member needs and respond with a list of suppliers who claim to meet that need. Also, to take input from suppliers and respond with a list of members who have declared an interest in the specific offering of that supplier.

EMINENT SCHOLAR IN SYSTEMS ENGINEERING AND SIMULATION

The Department of Industrial and Systems Engineering, and Engineering Management (ISEEM) at The University of Alabama in Huntsville (UAH) invites applications and nominations for an Eminent Scholar in Systems Engineering and Simulation. The Eminent Scholar, who will be appointed at the full professor level, is expected to provide leadership for research and instructional programs in systems engineering and simulation, as well as general support to other ISEEM and UAH programs. Duties will include interacting with the local and national technical and professional systems engineering community and serving as mentor to both students and to multi-disciplinary faculty teams.

Eminent Scholar qualifications include: (a) a doctorate in Industrial Engineering, Systems Engineering, or a closely related field, (b) a successful funded research and publication record in systems engineering, simulation, or industrial engineering; (c) an interest in supporting continued development of the systems engineering and simulation research and instructional programs and, (d) the ability to interact productively with the industrial community, government agencies, faculty, and students. Additional qualifications such as an undergraduate degree in engineering, work or research experience in information technology, and professional licensure or certification are also desirable.

UAH and the Tennessee Valley area provide an excellent high technology environment for collaboration, research, and consulting, with over 20,000 engineers and scientists in the Huntsville area. The ISEEM Department has ongoing working relationships with many local companies and government agencies, including Chrysler Huntsville Electronics Division, PPG Industries Aircraft Products, Lockheed-Martin, the Army Aviation and Missile Command (AMCOM), and the NASA Marshall Space Flight Center. Several major corporations, such as Boeing and Lockheed-Martin, are also expanding operations in the Huntsville area. The department has a large nontraditional student body with over 250 students in BSE, MSE, MSOR and Ph.D. programs. Six graduate concentrations are offered in the areas of Systems Engineering, Simulation, Engineering Management, Manufacturing Systems, Quality Engineering, and Operations Research.

Situated on the Tennessee River in the verdant Appalachian foothills, Huntsville's climate is temperate; opportunities for recreation, sports, and cultural activities abound in the immediate area. The cost of living, including housing, is very reasonable and local schools are of excellent quality.

Interested applicants should send their vitae to Professor Jerry Westbrook, Chair, Eminent Scholar Search Committee, ISEEM Department, The University of Alabama in Huntsville, Huntsville, AL 35899 (e-mail inquiries to westbrook@ise.uah.edu). The position will remain open until filled. Review of applications will begin in May 1998. *The University of Alabama in Huntsville is an Equal Opportunity/ Affirmative Action Employer.*

Vancouver
backgrd photo

INCOSE '98 PATRONS...To Date

The Patron firms supporting INCOSE '98 strongly enhance the quality of the symposium. The Planning Committee wishes to recognize this year's Patrons:

Platinum Plus	♦ **The Boeing Company**	http://www.boeing.com
Platinum	♦ **Raytheon Company**	http://www.raytheon.com
Silver	♦ **AlliedSignal Inc.**	http://www.alliedsignal.com
	♦ **Rational Software Corporation**	http://www.rational.com
	♦ **The Aerospace Corporation**	http://www.aero.org
Bronze	♦ **MacDonald Dettwiler**	http://www.mda.ca

For more information regarding the Patron program, please contact Mary Neudorffer at (310) 336-2870.

INCOSE '98 Summer Symposium

Eighth Annual International Symposium of the International Council on Systems Engineering

Begins July 26, 1998 in Beautiful Vancouver, BC.

The annual symposium is planned and ready to go on July 26–30, 1998 in Vancouver, BC, Canada. This symposium marks INCOSE's first internationally hosted event. An international community of system engineers will congregate to explore advancements in the practice and education of SE and extend their SE networking. The Vancouver host team has prepared an outstanding program of plenaries with guest speakers; technical sessions — tutorials, papers presentations, and panels; exhibits; and informal gatherings for networking and exchanging ideas. In addition, the Academic Forum has returned to be a vehicle for furthering education and prominence of system engineering in the academic environment.

A very special thank you goes to our Patrons. Their financial and managerial support is critical to successful symposia and INCOSE. We have recognized their support in our Patron's Program, see page 23.

We plan for more than 700 attendees to participate in this, INCOSE's flagship event. Our host hotel for technical sessions and meetings is the Hyatt Regency Vancouver. Across the street is the Hotel Vancouver, the site of our exhibits and networking receptions. These two hotels, plus the Renaissance Vancouver a few blocks away, provide primary accommodations for attendees. Many may not be aware, but summer in Vancouver, BC. is warm, blue skies, and a haven for tourism. Thus it is "high season" and hotels fill fast. Be sure to reserve your rooms early to avoid a last minute search for accommodations.

In addition to the fine technical program, your hosts have planned several opportunities to gather informally to share in the "spirit of the Northwest" while engaging with fellow attendees in discussions of systems engineering education, practice, processes, and tools. We have two receptions—an icebreaker to start off the week and a social hour preceding the annual banquet. Both will provide unique activity for your enjoyment. Our banquet will extent the symposium theme —"**People, Teams, and Systems**"— to offer a human and cultural viewpoint toward working together as Systems Engineers.

This event will be another outstanding symposium in the tradition of INCOSE. The host international city and community offers a global opportunity for understanding, sharing, and furthering the role of system engineering in the world. We, your Vancouver host committee, take great pleasure in inviting you to join us in Vancouver on July 26–30, 1998.

For details and more information on registration, visit our web site at www.mda.ca/incose/symposium.htm, or please contact University of Washington Engineering Professional Programs at uw-epp@engr.washington.edu or 206-543-5539.

Your Host Team

Traveling to Vancouver: Import/Export Regulations

James A. Sanchez, jasanchez3@mail.hac.com

This article may assist international travelers with customs export licensing issues for the temporary export of laptops, software (including encryption) and unclassified data. This article is meant only as an introductory guide. More specific information can be obtained from your company, international airports, travel agents, ports of entry, or government departments.

There are two general areas of interest, since most symposium attendees will be entering Canada for either the symposium, tourism or both. The traveler bears the brunt of responsibility for items that enter or leave each country. Items in your possession should be handled only by yourself or a duly authorized employee of a commercial carrier.

Personal items should be distinguished from corporate assets. Items being shipped should be clearly labeled, and include a packing list and applicable import/export documents.

■ **Department of Commerce, Customs.**

In general, it is suggested that expensive personal items, including jewelry, watches, cameras, camcorders, computers, etc. be registered with the customs service at any international airport. The item must have a model and serial number that can be recorded on the registration form. This registration can help to prove that the item you bring back into your country of origin was originally yours. An original purchase receipt or "invoice for temporary items" issued by your company may also serve this purpose. Corporate assets should be properly recorded by your company for export. Customs does not always check items, but the regulations are enforced and always changing.

The US, Canada, and other CoComm signatory countries, have restrictions on the removal of "high-technology" computer equipment. Some high-end laptops and workstations fit into this category. A license is required to transport such devices out of the signatory countries. For laptops with encryption software (e.g. Lotus Notes, Norton Utilities) that originate in the United States, some of the conditions are that items must be returned to the U.S. within a year, the exporter must maintain effective control of items, and that software is not to be downloaded to uncontrolled items. Loss or theft of controlled items should be reported. The last word that I received was that travelers from the U.S. carrying laptops are spared having to get a TMP license, but it is definitely a good idea to have proof that the laptop originated in the U.S.

Certain artifacts or cultural implements may not be brought back into the United States, e.g. ivory, tiger bone.

■ **Department of Agriculture.**

Many countries and states and territories of the United States control agricultural herbs and foods entering their borders. Other substances are also controlled, so keep prescription medications in original containers, and be aware of who is handling your luggage.

■ **International Traffic in Arms Regulations and national-security provisions apply.**

Many U.S. companies have a policy that classified data cannot leave the U.S. Contact your company's security office for guidance. Currently, the INCOSE does not have such a policy imposed upon its members. The 1998 INCOSE Symposium in Vancouver, B.C. will not have any classified meetings.

Regulatory Requirements: You may need to prepare necessary export documentation to travel from your country to Vancouver, British Columbia in Canada for the 1998 INCOSE Symposium. In the United States this preparation may include the Shipper's Export Declaration (SED) form. If you are carrying data that is under a State Department license, you may need to obtain a Certificate of Compliance from your own company's export expert.

Export Process: Contact your shipping department to generate a packing list, and have the responsible area, for example your company import/export department prepare your export documents.

Company Policy: Many U.S. companies state that classified data cannot leave the U.S. Contact your security office for guidance. The beginning of all electronic transmissions of information subject to export controls must cite the export license, exemption under the State Department, or Department of Commerce license authorizations. Electronic transmission of such information is to be encrypted.

Using a Carnet: A Carnet is an international customs document that exempts travelers from paying customs duties and Value Added Tax (VAT) for hardware exports to selected countries. It does not exempt you from export licensing requirements or from filing a Shipper's Export Declaration form.

Recordkeeping Requirements: If using License Exception TMP (U.S. Customs uses three letter acronyms — TMP stands for temporary), you should have a log sheet showing that the item was taken overseas and returned to the U.S. within a year. The log should be kept for 5 years from date of export.

■ **Corporate Asset Laptop Computer**

Get a License Exception–TMP Requirements for (TMP) Tools of the Trade:

1) Items must be returned to the U.S. within a year.
2) Exporter must maintain effective control of items.

■ **Commercial Off-the-Shelf Software (Mass Market)**

TMP for Software with Encryption (i.e. Lotus Notes, Norton Utilities)

News from Chapters

The Founding Reception of the German Chapter of INCOSE

Ernst Fricke, E.Fricke@lrt.mw.tu-muenchen.de

Introduction. On May 7, 1998 the German Chapter of INCOSE held its founding reception in Munich, Germany. This was the first major event of the German Chapter with the intention to generate wider public attention regarding systems engineering, INCOSE, and the chapter itself. The reception was sponsored by BMW and hosted in their Research and Development Center in Munich.

History. First activities to establish a German Chapter of INCOSE started in Spring 1996. In April 1996, the six Germans who were members of INCOSE met with some colleagues for a first casual exchange about SE and German activities. On that evening, the group of 12 people made the decision that it would be worthwhile to start regular activities on SE in Germany with the goal to build a German organization for Systems Engineers, preferably as part of INCOSE.

We started with regular meetings, each time including a technical presentation, hosted by the Fachgebiet Raumfahrttechnik (Institute of Astronautics) of the Technical University of Munich. Presenters have included BMW, Bosch, Daimler-Benz, Dornier Satellite Systems, Siemens and Munich Universities. The subjects ranged from concurrent and simultaneous engineering over risk and requirements management, the modeling of systems, and university courses on systems engineering.

The forming of the chapter itself was a minor problem; 25 members were easily found. Becoming a non-profit organization and sticking to the rules of INCOSE for chapters was a bit harder since we had to resolve some conflicting requirements. In August 1997 we officially became an INCOSE Chapter and in January 1998 we finally became a registered non-profit organization.

Structure and Activities. Currently the German Chapter has 36 members from 12 different companies/organizations from aerospace, automotive, electric/electronics and steel industry, as well as from tool vendors and three different universities. From the beginning, a major goal of the chapter was to have a high diversity in the companies represented by the members and a high commercial content to foster cross-fertilization between the industry sectors. With 30% student members (masters and PhD students) we have the highest

German Chapter and INCOSE booth at the reception


Dr. Wischmann (Dornier Satellite Systems) and Allen Fairbarn (President, UK Chapter)

share of students in our membership of all INCOSE chapters, which gives us hope for new ideas, dynamic activities and a stable basis for the future. With Dornier Satellite Systems GmbH we also have our first corporate sponsor, who is now also member of the Corporate Advisory Board of INCOSE.

Besides offering the technical presentations we have started a Web-Site (visit us at http://incose.lrt.mw.tu-muenchen.de) where information about our chapter can be found. Additionally we started a list of annotated SE literature, to help our members to easily find the right books for their problems. The AIAA/INCOSE primer was also translated into German and is now offered as a product to German speaking systems engineers.

The reception. The goal of the founding reception of the German Chapter was to present systems engineering and our chapter and its activities to a wider public audience. By winning Anton Ruf, Director of Central Organization and Director of Process Consulting in Product Development (BMW AG), as a speaker for the reception, his company also kindly agreed to sponsor and host the reception. Additionally we could get Monika Gonauser (Siemens AG, Corporate Technology, Director of Software and Engineering), and Dr. Gerhard Wischmann (DSS, Director of Engineering, of Dornier Satellite Systems), as our speakers. Unfortunately Monika Gonauser became sick and could not attend, so Gerd Höfner (Siemens AG, Corporate Technology, Head of Systems Engineering),

replaced her.

Having invited more than 600 people from all over Germany, 180 confirmed to come and 150 attended from over 40 different companies. We were especially happy to have strong support from INCOSE, by Bill Schoening (Boeing, INCOSE president), Mary Simpson (Boeing CAG), Ginny Lentz (United Technologies), Carol Gutierrez and Don Noel (Ascent Logic Corporation) from the USA and Allen Fairbairn, the President of the UK Chapter (Appledores Associate). Their attendance helped us very much by showing a working international network to our German attendees.

Business Cards of Munich, real beer mugs for our international peers

Bill Schoening presented INCOSE as an international and industry-driven organization and stressed the idea that a dialog of experience and ideas between European and American industry is expected to be very beneficial for both parties. It was a very interesting speech which got a lot of people interested in what INCOSE can offer them.

Bill Schoening, INCOSE President

Gerd Höfner (Siemens AG) showed in his presentation that systems engineering is an essential factor when facing the development of new products and handling the embedded complexity. The presentation focused on the different understanding of systems engineering that diverse business fields within Siemens AG require, and how this understanding is changing with changing requirements. Mr. Höfner expressed the interest of Siemens in an international exchange of experience and systems engineering-related developments, and highly supports the founding of the German Chapter of INCOSE.

Anton Ruf (BMW AG) showed that after initially being comparatively simple, many technical products are characterized by high complexity as soon as final user product interfaces have been realized. This product complexity has tremendous effects on the complexity of the development process. BMW faces these new challenges by bringing together in one place all people concerned with the system development, namely in their Research and Engineering Center. This enables short and fast communication and thus integrated product development teams. Anton Ruf pointed out that special emphasis has to be put on the fact that systems engineeing can not only be performed within technical departments but has to be applied as an overall strategy throughout all disciplines and company levels, especially the management disciplines. In the last months this led to a reorganization at BMW AG.

Dr. Gerhard Wischmann (Dornier Satellite Systems) showed that systems engineering has a long tradition in the development of highly complex satellite systems. Initially the central part in Dornier's systems engineering was to successfully perform one single project and produce one product at a time. Meanwhile the emphasis has shifted to a faster and cheaper development, while still producing complex technical systems. The upcoming challenge will be the serial development for satellite constellations. Dr. Wischmann pointed out that satellite business has to go back to simplicity. He compared satellite to automotive business and showed that they are going to have more and more similarities concerning market, complexity, processes, methods and tools.

Mr. Anton Ruf, BMW AG, during his presentation

Finally Dr. Bernhard Thomé presented the German Chapter. He described the motivation behind forming the chapter and the services it can deliver building on the whole INCOSE organization. The goals and activities of the chapter were described, with focus on its immediate potential benefit to every member.

After the technical presentations the attendees had the opportunity to exchange thoughts, ideas and experiences in a casual environment with information on INCOSE, the German Chapter and systems engineering in general. Moreover, BMW showed their new 3-series and informed on its development process and system engineering tools. Dornier Satellite Systems exhibited a model of their environmental satellite ENVISAT, which they built for the European Space Agency. Vivid discussions went on for three hours, fueled by an excellent buffet sponsored by

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BMW AG. We received very good feedback by all attendees and hope to get some more German members in the next weeks.

We want to thank everyone who made this event possible, the international members who participated, the speakers, and especially BMW AG for hosting and sponsorship.

Midwest Gateway Holds Successful Tutorial and Tour

Don Hess, Chapter Secretary,
dhess@mdc.com

Recent activities of the Midwest Gateway Chapter have been a dinner meeting, a tour of the Ford Motor Co. St. Louis Assembly Plant, and a full-day tutorial on Requirements Definition and Management. All of these events are planned based a survey of our local members and their stated priorities.

Our dinner meeting speaker, Tom Cummings of Invention Machine, presented an automated methodology to assess functional requirements and allocations using a technology invented in Russia and now being offered as a PC based product. It offered a new dimension for near real-time functional allocations based upon over 30,000 inventions and processes from around the world.

The tutorial on requirements was presented by Ivy Hooks at Washington University. Attended by 50 people, all agreed that Ivy's entertaining and informative presentation yielded information and techniques that are usable every day for all systems engineers. The pleasing surroundings, great refreshments and lunch offered by our Washington University hosts made for a memorable event.

We're now looking forward to a social outing at a St. Louis Cardinals baseball game and an early peek at the papers to be presented by our St. Louis peers at the International Symposium in Vancouver.

See you in Vancouver!

Silver State

Jesse Teal, jesse_teal@notes.ymp.gov

The University of Nevada, Las Vegas, (UNLV) awarded, for the first time, certificates in Systems Engineering to eight engineers who completed a five-course, two-year program. The program was developed, co-sponsored and instructed by members of the Silver State chapter.

During February, the Silver State Chapter joined over 25 other Professional Engineering Societies in participating and sponsoring National Engineers Week. During the week of February 22-28, the professional engineering societies provided speakers for local high schools and provided exhibits at one of the local malls. The week also included a mouse trap race car and egg drop events for local students. The conclusion of the week was an Engineering Week Finale/Banquet, which recognized the contributions from key members of the Professional Engineering Societies. Since this was Silver State Chapter's first year to participate in the National Engineering Week, it was a learning experience. However, the activities provided will be beneficial next year to help communicate the goals and objectives of INCOSE to public and private sector as well as the high school and college level students.

The chapter has had two dinner meetings with speakers and a lunchtime meeting since February. Ginny Lentz was the chapter's guest for the March meeting and led us through a brainstorming and multi-voting session on the future structure of INCOSE. The discussion focused on the needs and criteria at a local chapter level.

At the April meeting, Dorothy McKinney, Mission Success Director for Ground Systems and Software, Lockheed Martin Missiles and Space Company, gave an excellent presentation on "Using New Systems/ Software Techniques and Tools: from Theory to Practice." Her presentation covered the gap between theory and practice; using commercial-off-the-shelf software; rapid prototyping; object oriented development; and new languages and technologies. She shared a great deal of insight, based on her years of experience, with the chapter members. She discussed, at length, difficulties associated with the use of commercial off-the-shelf software on work that had been performed by Lockheed Martin.

The speaker for the May meeting was Joseph Burba from Ford. His topic was "The Electric Vehicle: The Complete Story." His talk focused on the complex issues that are inhibitors to successful commercialization of electric vehicles and the role that systems engineering principles have in addressing these issues.

One more dinner-speaker meeting and a tutorial are being planned for the remainder of the year.

Central Florida

Ben Berauer, bfbc@eci-esyst.com

Our fledgling chapter has been slowly growing since January, with membership in the combined Tampa Bay and Orlando area about 60 people. To this aim, efforts are underway to reach out into the community and to further increase membership outside of the core group that started the chapter.

The chapter has put together an organization that is now addressing the issues a new chapter needs to tackle. We have had monthly meetings and programs, and published a monthly newsletter. Information on programs past and scheduled are available in the newsletters and on the chapter's web site (www.netcom.com/~rlmrchnt).

1998 Officers in the Tampa Bay Area:

President: Frank Dougherty (FrancisDougherty@ij.net)
Vice-President: Ben Berauer (bfbc@eci-esyst.com)
Treasurer: Bob Marchant (rlmrchnt@ix.netcom.com)
Secretary: Wes Calhoun (wescal@cftnet.com)

The Systems Engineering Society of Australia (SESA)

Herve Rochecouste, herve@adacel.com.au

The purpose of the Systems Engineering Society of Australia (SESA) is to harness available resources in a synergistic team to enable the improvement of the systems engineering practice and culture in Australian industry, academia and government. SESA is a Technical Society of the Institution of Engineers, Australia (the IEAust). The IEAust is an umbrella organization for professional Engineers with a membership base of 70,000.

The mission of SESA, derived from INCOSE, is: *To foster the definition, understanding, practice and advancement of Systems Engineering in Australian Industry, Academia and Government.* SESA currently has 300 financial at a rate of about 10% per year. SESA ended the financial year with a positive bank balance of around $36K. SESA is affiliated to INCOSE (Region VI), and has four Australian chapters in Sydney, Canberra, Melbourne and Adelaide.

Although SESA is not a chapter of INCOSE, it operates in a similar fashion due to its international affiliation status. SESA was formed in 1994 when INCOSE was still mainly a U.S. based national organization with no international chapters (NCOSE). Now that INCOSE has expanded internationally, there are valid grounds for the two organizations to work towards closer relationships. An example of one model to evolve toward this aim is for SESA to be viewed as a large chapter of INCOSE, whilst locally in Australia it would continue operating as a Technical Society of the IEAust with four chapters. Working with the IEAust has been the reason for the strong growth of SESA in Australia, as it is viewed locally as an organization that can influence and change the SE industry in Australia, instead of just an overseas chapter of a U.S. base organization. (The ratio of 300 members for a population of 17 million in Australia is higher than the INCOSE membership/population ratio in the U.S., or anywhere else in the world).

Key SESA Activities in 1997:

- Setting up an email reflector to service members and support working groups
- Production of quarterly newsletters
- Quarterly executive meetings
- Defense Workshop in July 1997, and Systems Engineering Tutorial at Australian Defence Forces Academy (ADFA)
- Distribution of INCOSE Journals to members
- Production (under license) of INCOSE 97 Los Angeles Symposium CD-ROM proceedings and distribution to members
- Monthly meetings of the four chapters in Sydney, Canberra, Melbourne and Adelaide
- AGM in November 1997

Planned SESA Activities for 1998:

- Setting up of a SESA web site
- Production of quarterly newsletters
- Quarterly executive meetings
- Start the planning of INCOSE 2001 Systems Engineering International Symposium in Sydney
- Distribution of INCOSE Journals to members
- Production (under license) of INCOSE 98 Vancouver Symposium CD-ROM proceedings and distribution to members
- Monthly meetings of the four chapters in Sydney, Canberra, Melbourne and Adelaide
- Regional symposium with INCOSE in Canberra in November 1998 (SE98), http://www.effect.net.au/OneStop
- AGM in November 1998
- Production and distribution of the SESA 1998 Journal

San Francisco Bay Area

Lew Lee, President, lew@svl.trw.com

The chapter thanks the INCOSE Technical Board and everyone involved who supported us in the creation of the INCOSE *Systems Engineering Handbook*. We are ecstatic with the warm reception it has received from the community. With the continued guidance of senior editor, Tim Robertson, this valuable guide will be maintained and improved with use. You can obtain the handbook through the Corporate Advisory Board member for your organization, or you can purchase a copy through the INCOSE Central Office. The handbook is $20 for members and $25 for non-members. (See article on page 20.)

Monthly meetings have been a cornerstone in our chapter's success. GTE Government Systems in Mountain View provides us with an excellent meeting facility. Dr. David Preklas is our host as well as serving on the chapter's board of directors. Through his efforts, GTE generously supports us with a superb staff and their equipment to videotape our monthly meetings. Our videotape library is a valued resource for our chapter and INCOSE. We invite you to browse our listing of monthly meetings on our website at http://www.relay.net/~lew/programs.html. Videotapes from our library are available for short term loan by contacting Hugh Calvin (instructions are posted on the web page).

Our recent monthly meetings have included:

- May 12, John E. Nast (Nast & Associates), Product Design Management: *A Commercial Systems Approach to Configuration Management*
- April 14, Carol J. Gutierrez (Ascent Logic Corp.), *Developing a System Solution in a Commercial Environment*
- March 10, Joel M. Koppelman (Primavera Systems, Inc.), *Innovations in Enterprise Project Management — Successfully Manage Projects and Resources with Primavera Project Planner*

Our chapter officers and board of directors have been conducting an in-depth survey of the membership to aid us in charting a course for the future. Our survey conducted in 1995 provided the board with the guidance it needed to create a successful mix of valued benefits.

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Upcoming events for the San Francisco Bay Area chapter include the following:

- July 14, SFBAC monthly meeting. Discussion facilitator: Dorothy McKinney (Lockheed Martin Missiles and Space), *Network Enhancement Opportunity.*
- August 11, SFBAC monthly meeting. *Program to be announced.*
- September 15, SFBAC monthly meeting. *Program to be announced.*

All meetings are held at the GTE Government Systems in Mountain View at 5:30 p.m.

Inland Empire

Shirlee.Flowers@trw.com

The Inland Empire Chapter (IEC), located in San Bernardino, CA, has elected new officers for 1998-99 year, effective in May of 1998.

- President: Shirlee Flowers, TRW, Inc.
- Vice-President: Archie Vickers, Kelly Space and Technology, Inc.
- Secretary: Petrus Kaufman, TRW, Inc.
- Treasurer: Jack Brinker, TRW, Inc.
- Vice-President of Systems Engineering Practices: Nicholas F. Kfoury
- Vice-President of Systems Engineering Development: Wayne Jordan

The chapter is in the process of re-vitalizing our membership locally and had a meeting on June 22nd, 1998 at the University of California, Riverside, CA University Club. The speaker will be Ronald J. Weis of Naval Warfare Assessment Division, Norco, CA.

Washington Metro Area

dnwlee@moon.jic.com

The Washington Metropolitan Area Chapter members were exposed to an interesting mix of topics during our monthly dinner meetings in the first half of 1998. Speakers included:

- Steve Marcom and Greg Fox presented "A Software Development Process for COTS-based Information System Infrastructure;"
- Bernie Rudnick discussed Systems Analysis for Effective Planning;
- Bill Thompson focused on his work for Mission Analysis in the FAA Acquisition Management System;
- Steve Dam updated the chapter on C4ISR Architecture Framework Application to Airborne Reconnaissance; and
- Dr. Ron Luman presented the results of his PhD dissertation on Quantitative Decision Support for Upgrading Complex Systems of Systems.

Upcoming chapter meetings are listed at the end of this article. If you are in the Washington DC area, please attend!

We are planning an East Coast Regional Conference for 1999 in the Washington, DC area. Details on dates and topics will be available shortly. For more information, contact WMA Chapter Vice President Jim Armstrong at armstron@software.org. The latest information on WMA Chapter activities is available on the World Wide Web at www.vtcorp.com/wma-incose through the ongoing support of Vitech Corporation.

The chapter sponsored a tutorial on *Systems Engineering – The Complete Process,* with Dr. Dennis Buede and Jim Long as instructors. This was our most successful tutorial to date with almost 90 participants. Both TRW and TASC took advantage of the attractive training opportunity by sponsoring 10 employees each. Many of the participants took advantage of our special tutorial/INCOSE membership rate and joined INCOSE as new members. The chapter's June tutorial presented by Dr. Ernest Forman focused on Multicriteria Decision Analysis for System Engineers.

The chapter continues to focus on outreach efforts within the local community. One ongoing effort is participation as an active member of the DC Council of Engineering and Architectural Societies. Another was support of Lockheed Martin's National Engineering Week activities by setting up an information booth and participating on a panel on local engineering societies. The chapter is also initiating a Corporate Affiliate Program under the leadership of Director Abe Meilich. The intent is to build a constituency of supporters within the local companies interested in systems engineering and getting them more involved with INCOSE. A second goal is to build a greater awareness of available systems engineering resources within the Metropolitan Washington technical community.

The following meetings are currently scheduled. The location for all meetings is:

Boeing Information Services
Level A Conference Room
Tycon Tower
8000 Towers Crescent Drive
Vienna, Virginia
Time is always 6:30 pm

- July 14, Symposium Dry Run
- August 11, An overview of the National Airspace System (NAS) Architecture, Mr. Mike J. Harrison, ASD-101, Deputy Program Director of Architecture and Systems Engineering.
- September 8, "Getting a Handle on Wicked Problems," Jeff Conklin, Group Decision Support Systems, Inc.

INCOSE Infrastructure

Center of Excellence Submits First Proposal

Eric Honour, ehonour@hcode.com

Last month, the virtual INCOSE Systems Engineering Center of Excellence (SECOE) submitted a proposal to the National Science Foundation for funded work to be performed by INCOSE. This is the first time that any part of INCOSE has submitted such a proposal, and it is part of a new emphasis to treat the organization as a viable, non-profit business in addition to being a membership organization.

The proposal is to conduct a one-year Best Practices Analysis Workshop, using Internet technologies to elicit and analyze best practices in the design and development of complex systems. The workshop is proposed to start in August 1998. The results of the workshop will be a public, web-based compendium of proven best practices, comprising:

- Identified best practices in complex systems development
- Description of the practice in context of a higher framework of systems development
- Development phases in which the practice is identified as useful
- Identified source of the practice, to allow understanding of its scope and context
- Theoretical or empirical analysis of the practice to ascertain:
  - Applicability within known systems development paradigms
  - Applicability within system types and/or characterizations
  - Bounds on applicability of the practice
  - Theoretical or empirical rationale for the practice being useful

These results will be documented in formal, reviewed papers on the workshop Internet site. The resulting papers will also be submitted for publication in the INCOSE Journal. All SECOE participants will automatically be registered to participate in the Best Practices Analysis Workshop. Participation is open, however, and other researchers and contributors from academia, government, or industry are encouraged. The SECOE web site http://www.secoe.org will host the workshop using passwords, bulletin boards, chat, and Internet video-teleconferencing. Throughout the workshop, both identified practices and the analyses will be available on the Internet site.

The knowledge base will grow as time progresses, providing accessible information for other research. SECOE is continuing to develop further funding proposals, including a Systems Engineering Effects project to gather statistical data from participating systems companies. The data will be used to empirically analyze which SE practices appear to contribute to project success under what conditions. Participating companies will receive the significant competitive advantage of early and more complete access to the results.

SECOE is an INCOSE-sponsored, U.S.-based association of over 25 universities dedicated to research into complex systems development. It is one element of a Network of Excellence that also includes the UK-based STEFFIE and other burgeoning efforts.

Officer Nominations – LAST CHANCE!

Eric Honour, ehonour@hcode.com

The Nominations Committee is in full swing, gathering names of those who wish to run for INCOSE offices in 1999 and 2000. The annual elections will be this fall, with ballots going to members at the end of September. To meet this schedule, we need candidates now.

In addition to candidates for this year, the committee is also looking ahead to next year and the year after. If you are active in INCOSE and interested in moving toward INCOSE leadership, or if you know of someone who is, please contact Past President, Eric Honour, at the above email address.

Offices that are open for election this year include:

President-Elect (President 2000)
Secretary
At-Large Director
Region I Director (Industry)
Region II Director (Academic/Govt)
Region III Director (Academic/Govt)
Region IV Director (Academic/Govt)
Region V Director (Academic/Govt)
Region VI Director (Academic/Govt)

New Ways & Means Chair

Bill Schoening, schoening@inlink.com

I am very pleased to announce that Joe DeFoe of Lockheed Martin has accepted the chairmanship of the Ways & Means Committee. Joe was Secretary of INCOSE in 1995-96 during which time he put in place many of the procedures we use today.

Art Morrison of The Boeing Company, our retiring Ways & Means Chair, has done an outstanding job assisting the Board of Directors and the Officers to put in place a comprehensive set of policies and to update the Bylaws. "Retiring" is perhaps the wrong word. Art is co-chair of the Technical Committee for the 1998 Symposium in Vancouver. My thanks to Art for everything he has, and is, continuing to do for INCOSE.

Chapters Committee

Co-Chairs: Ken Kepchar, gkkep@inlink.com, and Sam Rindskopf, m.sam_rindskopf@ymp.gov

Let me start out by discussing the purpose of the Chapters Committee. First and foremost the committee provides the link between the chapter leadership and INCOSE. Therefore chapter presidents are members by virtue of their position. The Chapters Committee meets twice each year during the International Symposium and the International Workshop. These meetings provide the chapter leaders an opportunity to meet and share lessons learned, identify issues, discuss solutions, and find out what works and what doesn't when it comes to maintaining an active growing chapter.

The Chapters Committee also maintains the Chapters Reflector email site for use as a communication tool between the meetings. We also have a Chapters Committee page on the INCOSE Website at http://www.incose.org/cmtes/lcc.html. We will be using this location to post items such as the Chapter Start-Up Kit, the INCOSE Regional Maps, and the criteria for becoming a chapter.

The Chapters Committee is also charged with encouraging the development of new chapters. We provide a point of contact for anyone interested in developing a chapter in their area. We work closely with these individuals and provide information and guidance. For example, the committee has a "Chapter Start-Up Kit" that provides guidance, tips and other valuable information for use in starting a chapter.

The Chapters Committee is responsible for defining and recommending the INCOSE Geographic Regions. The present regional map was developed and presented during the last International Workshop in Dallas.

During the upcoming International Symposium in Vancouver, we are again planning to host a joint meeting with the Membership Committee. The meeting will be in two full-day sessions on Sunday and Monday. Chapter presidents or their representatives should plan to attend one of these sessions. We will be reviewing the status of the work led by Jim Heaney on "Organizational Involvement at the Chapter Level," and review the status on the development of Tutorials & Speakers List. Region and chapter status reports will be presented by each region director and chapter president. We will also discuss topics/issues raised by the chapter presidents.

During the symposium, we will also be hosting a session on how to start up a chapter. This session will provide anyone interested in starting a chapter an opportunity to get the information they need. Also invited are those individuals who have had experience in this process and those who are currently going through this process.

In closing, let me emphasize that if there are topics your chapter wishes to discuss at Vancouver, please contact either Ken or myself at the email address above, or by calling Ken Kepchar at 314-234-8156 or me, Sam Rindskopf at 702-295-3943.

Retrieving the INCOSE Membership Directory

Lew Lee, lew@svl.trw.com, Dona Lee, donalee@dynsys.com

The INCOSE and SESA Membership Directories are available on the INCOSE web site at http://www.incose.org/members/ for both Windows and Macintosh users. The files are password protected and self-extracting. Instructions for downloading the files and uncompressing them are provided on the web site as well. Call the INCOSE Central Office at 1-800-366-1164 or send e-mail to donalee@dynsys.com with your request.

Three files are provided within the zipped archive(s): Introduction to INCOSE (RTF format), Membership (text), and SESA Membership (text). The Introduction file contains descriptions on the two membership files and additional information on using the files on a word processor, spreadsheet, and other applications.

This directory contains information about all INCOSE members other than those who specifically asked to be excluded from the directory. It is a direct copy of the information held in our central database as of March 15, 1998. Note that the central database is updated daily, and that those more current records are used for all mailings.

INCOSE is providing this directory only to current members, and it is to be used to further the goals of INCOSE. It is INCOSE policy that member listings of any type are not to be used for any commercial purpose. For example, providers of systems engineering courses or tools are not to use the information herein as a mailing list for course or tool brochures.

Please report any problems you find with the directory, as soon as possible, to the INCOSE Office at incose@halcyon.com, 800-366-1164 (toll-free U.S.), or +1-206-441-1164. The Membership Committee issues this directory on a regular basis. Comments about the format, or what other information should be included, are welcomed and should be sent to donalee@dynsys.com.

MEMBERSHIP:

When "Because" Is an Insufficient Answer, or… Going Ape for INCOSE

Membership Committee Co-Chairs
Lew Lee, lew@svl.trw.com, and Dona Lee, dnwlee@moon.jic.com

"What benefits will I derive from being a member of INCOSE?" is a frequently asked question posed to the INCOSE Membership Committee Co-Chairs. The most direct answer is the List of Benefits that can be found on page 28 of the INCOSE Symposium brochure and on the INCOSE website at www.incose.org/mem-ship.html. Lists such as these are designed to be a starting point and a framework to be used by a prospective member in deciding to join our organization. Personal testimonials and case studies offer a more detailed answer. A sampling of benefits on a more personal note can be found on the North Star Chapter's website at http://www1.minn.net/~brezinsk/.

One of the most entertaining ways to describe a tangible benefit is with the following story introduced to us on the INCOSE email discussion list by Past President Eric Honour:

> In a cage there are five apes. In the cage hangs a banana on a string over some stairs. Before long, one ape will go to the stairs and start to climb towards the banana, but as soon as he touches the stairs, all the apes are sprayed with ice cold water. After a while, another ape makes an attempt with the same result—all the apes are sprayed with cold water. After awhile, if an ape tries to climb the stairs, the other apes will try to prevent it.
>
> Now, remove one ape from the cage and replace it with a new one. The new ape sees the banana and wants to climb the stairs. To his horror, all of the other apes attack him. After another attempt and attack, he knows that if he tries to climb the stairs, he will be assaulted.
>
> Next, remove another of the original five apes and replace it with a new one. The newcomer goes to the stairs and is attacked. The previous newcomer takes part in the punishment with enthusiasm.
>
> Replace another original ape with a new one. The new one makes it to the stairs and is attacked as well. Two of the four apes that beat him have no idea why they were not permitted to climb the stairs, or why they are participating in the beating of the newest ape.
>
> After replacing the fourth and fifth original apes, all the apes which were originally sprayed with cold water have been replaced. Nevertheless, no ape ever again approaches the stairs. Why not? *Because that's the way it's always been around here.*

Where does one go to learn the *whys* of existing systems engineering practices? Where does one go to hear the *hows* of moving from theory to practice? An excellent place to start is examining INCOSE products in printed form and electronic media. Read this copy of ***INSIGHT*** from cover to cover. Consistent attendance at chapter programs and tutorials provides opportunities for interaction and professional networking. Participation on an email discussion group provides a wealth of knowledge and experience, and has been demonstrated to be an invaluable resource for problem solving.

Thanks to the vision of the founders of INCOSE and those who continually strive to understand and make us aware why we do things in systems engineering, we are no longer willing to settle for the answer, "Because that's the way it's always been around here."

People on the Move

Gregg D. Armstrong has moved from Boeing to Primex Aerospace.

Mary Redshaw is now with ARINC, supporting the Naval Air Warfare Center.

Eric Honour, INCOSE Past President, has left Harris Information Systems Division to create a consultation and research firm that he appropriately named Honourcode, Inc. He is coordinating the development of the INCOSE Systems Engineering Center of Excellence (SECOE) while also assisting commercial companies to improve their development of complex system products. He is remaining in the Melbourne, Florida area. You can reach Eric in his new work at (407) 253-8969 or ehonour@hcode.com.

Industry News

International System and Software Standards Update

Jerry Lake, lakejg@mindspring.com

The JTC1 Subcommittee 7 (SC7) of the International Organization for Standards met in Johannesburg, South Africa during May 1998. I represent the INCOSE on the SC7 Life Cycle Management Working Group (WG7). The following is my report on the outcomes of the meeting.

Two international standards are the focus of WG7—ISO/IEC 15288 *System Life Cycle Processes* and ISO/IEC 12207 *Software Life cycle Processes*. The software standard was published in 1995. Since then the ISO/IEC 15271, a guide for implementing ISO/IEC 12207, has been published. A software maintenance standard, ISO/IEC 14764, is in the final stages of International Standard publication. A Project Requirements document for the revision of ISO/IEC 12207 was approved by the SC7 at the May meeting. The revision of 12207 will proceed in parallel with the preparation of 15288. Initially, 12207 will be amended to correct misunderstandings in the 1995 standard. Then, by 2005, the entire revision will be completed. This approach was taken to protect the investment of those countries who have translated the English version of the standard and implemented it within their countries.

The ISO/IEC 15288 preparation is moving along much better than last reported. The third version of the Working Draft (WD) is in preparation and will be available for national body review after 20 August 1998. The WD1 and WD2 that came out of the Brisbane meeting last November, and comments on these versions by the participating nations and other bodies (US, UK, France, Australia, Japan, Sweden and NATO) were used to form the basis for preparing draft inputs to the editors for the WD3. It is my opinion that the output by subgroups assigned to write drafts of specific sections of WD3 will provide much better input to the editors than came out of Brisbane efforts. The 15288 projected date of publication as an international Standard is now January 2001.

I was assigned as a temporary editor for 15288 during the Johannesburg meeting. Also, I led the subgroup preparing text for the Technical Processes. Purpose statements, outcomes and activities and tasks were prepared for nine processes. The first four are for system design: acquirer requirements definition, other stakeholder requirements definition, system requirements definition, and system architecture design. The next four are for system product realization: system architecture design implementation, system product validation, system product verification, and system product transition. The last process, systems analysis, is implemented to provide technical support to the other eight processes. A figure was prepared showing how these 15288 processes are intended to be used for creating the system and the interface with 12207 for software component creation.

Published ISO standards can be obtained from the American National Standards Institute (ANSI). Working Drafts (WDs) of ISO standards are only available for working group review and use. Once approved by the working group, a Committee Draft (CD) is released by the working group. This version is available for all working groups of SC7 to review and comment. Once the CD is approved by SC7, a Draft International Standard (DIS) is prepared and balloted. A successful ballot results in publication of the International Standard.

Status Report on EIA 632: A Standard on Processes for Engineering a System

James N Martin, j-martin@ti.com

The Standards Proposal Ballot Draft of EIA 632 was reviewed last August through September. Since then the EIA 632 Technical Committee has been resolving the 700+ comments received from that review. Since technical changes were made to address these comments, a 60-day reballot is required. Revision A of the SP Ballot Draft document was delivered to the balloting group in May. Ballots and comments are due in July.

Generally the balloting group consists of active members of the EIA G47 Systems Engineering Committee. INCOSE is normally included in the balloting for standards relating to the practice of systems engineering. Since INCOSE is a member of the balloting group, a review internal to INCOSE will be held with a group of key reviewers. Donna Rhodes and John Snoderly are coordinating this review for INCOSE.

The general public is allowed to review this document and provide comments to the formulating committee. To obtain a copy, please contact Global Engineering and ask for SP-3537-A. In the U.S., you can call them at 800-854-7179. You can also order documents from their webpage (http://global.ihs.com/).

If this second round of balloting is successful, release of EIA 632 as a full standard can be expected to occur by September 1998. Below is a summary of the major changes made to the document.

SUMMARY OF CHANGES.
From: EIA 632 Standards Proposal Ballot (July 1997)
To: EIA 632 SP Ballot Rev A (May 1998)

All the changes since the original SP ballot (SP-3537) were made in response to the comments received. Over 700 comments were addressed

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during the comment resolution period. The majority were accepted and incorporated into the current version. The major changes are summarized below. Hundreds of minor changes were made for readability and to respond to specific comments.

1 Eliminated Part 2 (SP-4028). Several commentors cited redundancy and confusion with the material in Part 2. Some saw much of it as handbook material. Moved the essential material back into the main document (SP-3537). About 75% of Part 2 was dropped.
2 Process hierarchy flattened. Process⇒activity⇒task hierarchy found confusing by several reviewers. Went from five processes to 13. Some important tasks (such as fabricate, assemble and integrate) were elevated up to process level (e.g., Implementation Process) since several reviewers thought these were not given enough emphasis.
3 Reduced number of requirements (shall statements) from about 200 down to 33. Only the essential items remain as requirements.
4 Specific tasks are no longer recommended (via "should" statements) but instead are designated as "representative." Most of the task figures were eliminated; only one remains. The representative tasks were simplified and presented as lists instead of figures.
5 "Representative outcomes" of these tasks are outlined in Annex C.
6 "Control loops" were eliminated since these appeared to cause confusion. However, where iterations and feedback are considered essential, related tasks have been included in the representative task lists. Also, where applicable, information flows are designated in figures, or interrelationships specified in the text.
7 Definitions of key concepts and terms. Most of this was moved to the glossary and to Clause 6 on Application Key Concepts. Some were eliminated.
8 Tailoring is no longer mentioned. Many reviewers had trouble with what was said about tailoring. It was determined that it would difficult to address tailoring in a general manner that would be satisfactory to the majority. This appears to be a domain-specific issue and will be addressed in a different manner depending on many factors such as industry custom, customer desires, contractual situation, etc.
9 Application Context moved from up-front to behind the Requirements Clause 4. The flow now is logically arranged from general requirements for processes (Clause 4), to application of the processes for engineering a system (Clause 5), and then the Application Context within an enterprise (Clause 6).
10 Definition of system was changed from "end products plus their associated processes" to "end products plus enabling products." Enabling products use the associated processes. A new figure (in Clause 6) is provided to illustrate the system elements.
11 Development life cycle was simplified and changed to "engineering life cycle." The discussion of various life cycles was eliminated and the enterprise-based life cycle has been placed in Annex B to illustrate application of the engineering life cycle in the context of the enterprise-based life cycle to engineer or reengineer a system, or portion thereof.

The Congressional Research Service - What is it?

Frederick Martin, AAAS/IEEE Congressional Fellow, fmartin@us.net

(This discussion is neither an official or unofficial product of my position as a Congressional Fellow at CRS. Any opinions are those of the author and not of CRS or its employees. Most of the descriptive material was taken from the two CRS reports listed at the end under "sources.")

> *Before a great republic there is no subject to which a member of Congress may not have occasion to refer.*
> *—Thomas Jefferson, c. 1813*

My new office is in the Congressional Research Service (CRS), located in the Library of Congress (LOC). Shortly after I had settled into the Senate Committee on Energy, the staff played musical chairs and the person with whom I signed on left for greener pastures. Subsequently, the Committee became inhospitable and I was obliged to find a new location. WDC is an exercise in changing of the guard.

What is the Congressional Research Service? From where did it come? In 1800 Congress appropriated $5000 for a library to serve their needs; the British torched it in 1812. A month later Thomas Jefferson offered to sell 6700 books from his personal collection to the Joint Committee on the Library, accompanied by the above inspiring quote. Also, he was broke and needed cash.

During the 1820s, Congress requested the Librarian, George Watterson, to provide them with "facts, dates, acts, official communications, and even lines of poetry." However, President Jackson sacked him in 1829, claiming that he had been the Librarian for "one side of the aisle only." Since then the LOC has remained aloof of partisanship and accurate research became the guiding principle.

In 1874 Congress requested the LOC to include two newspapers representing contrary political views

from each state. The next big change in the LOC came in the Congressional appropriations of 1914 and 1916. Beginning in 1911 and 1912 and continuing for several years, representative John Nelson (WI) and Senator Robert M. La Follette, Sr. (former Governor of Wisconsin), and a number of other legislators introduced proposals to establish a legislative reference service within the LOC. Known as the "Wisconsin Idea" the proposals called for the establishment of a cooperative relationship between academic and technical expertise and Congress to help formulate and affect legislative goals. In July of 1914, Congress passed legislation to establish the Legislative Reference Service (LRS) within the LOC "to employ competent persons to prepare such indexes, digests, and compilations of laws as may be required for Congress and other official use." The following year Congress broadened the mandate to authorize the Librarian to employ competent persons to gather information "for or bearing upon legislation, and to render such data serviceable to Congress and Committees and Members thereof."

In the words of Senator La Follette, Sr.:

> *In short, the aim of the new provision[s] is to make serviceable in suitable form for immediate use the legislative resources of our national library. By adopting it Congress has taken an important and necessary step toward rendering the business of law making more efficient, more exact, economically sound and scientific. (La Follette's Weekly, July 4, 1914)*

The LRS proved to be popular. From 1920 to 1946 the annual requests for information rose from 1,604 to 16,444; WWII boosting the demand. The staff also expanded to 95 of whom 72 were professionals, though mainly at low GS levels. A War Service Section was added with a staff of 38; it answered inquiries from various war agencies as well as Congress.

In 1946 Congress created a Joint Committee chaired by Senator Robert M. La Follette, Jr. and Representative A.S. Monroney. The committee, known as the La Follette-Monroney Committee, created the Legislative Reorganization Act. Because of the Great Depression followed by WWII, Congress felt that it had drifted into a secondary position relative to the executive. Representative Everett Dirksen complained, "we merely approve or disapprove plans, and estimates prepared by" executive agencies. Congress felt it needed to modernize for the tasks of the post-war era.

The 1946 Legislative Reorganization Act greatly increased the mission and responsibilities of the LRS. It created an organization for the exclusive use of Congress and gave it a firm statutory status. Upon request, the LRS was to advise and assist any Member or Committee "of either House in the analysis, appraisal, and evaluation of legislative proposals pending" or of "recommendations submitted to Congress, by the President or any executive agency." The Act authorized increases in appropriations over a three-year period and authorized the hiring of "senior specialists" with expertise corresponding to the jurisdictions of the standing committees. These specialists would be equivalent to the senior members in the executive agencies. Congress was seeking a source of expertise that was independent of the executive branch, nonpartisan, and worked exclusively for Congress.

For the next 20 years, the significant trend in the LRS would be an increasing range of complex issues analyzed in response to the needs of Congress while developing legislation.

In 1965 Congress created the Joint Committee on the Organization of Congress. This led to the Legislative Reorganization Act of 1970. Among its provisions, it reemphasized the importance and necessity for the independent research organization for Congress that was created in the 1946 legislation. To reinforce this program the 1970 Act made several changes:

1. The LRS was renamed the Congressional Research Service (CRS).
2. The Director was to promote greater liaison between CRS and the committees of Congress
3. CRS would have a separate, detailed budget within the LOC budget and submit an annual report describing the CRS activities.

The legislation also specifically recommended the CRS to "assist committees in determining the advisability of enacting particular proposals, as well as the probable results that would follow the enactment of alternatives; and to assist committees in evaluating alternative methods of accomplishing the results those proposals seek to achieve."

This legislation and subsequent legislation during the 1970s greatly expanded the CRS. In 1970 it had budgeted for 323 positions and by 1975 the Service had reached 703 positions. Since the mid 1970s the CRS budget has been included in the Title I of the Legislative Branch Appropriations Acts.

Legislation drives the CRS activities; it works exclusively for Congress and its research products are available only to Congress (although Congressional offices can provide data to constituents). At the request of Congress or on its own volition, CRS prepares reports and briefs on the legislative issues of concern. CRS also provides phone consultations, one-on-one briefings in Member offices, general seminars, and workshops. CRS treats all requests from Member and committee offices as confidential and prepares materials exclusively for that office. General reports and issue briefs are also available on the World Wide Web, to Congress only. In the legislative process speed and timeliness are paramount and many requests are reported back within 24 hours. Also CRS anticipates the legislative priorities for the session and prepares

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reports, briefs, and updates in advance covering those issues.

There is a colossal volume of activity. The 1997 Annual Report states that 531,162 requests were received and completed for that year. Of these, 137,930 requests were for specific analysis, information, and research. The remainder was reference center, electronic, and product requests. CRS also provided seminars and training to 11,202 participants. In 1997, 68,651 new entries were placed in its information system.

In FY 1997, CRS had 747 employees in nine divisions covering the major categories of issues. Approximately 90 percent of the budgeted $62,641,000 supports salaries and benefits. The budget has been flat for the past several years and the current level of employment is down from a 1991 high of 850 employees. Moreover, since Office of Technology Assessment (OTA) was disbanded by Congress, the CRS has had to take on some of its functions. This reflects to some degree the desire to decrease overall Federal budgets and to some degree the Republican Congress's reliance more on philosophy, inputs from business and commerce, and less on analytical details when crafting legislation.

I am stationed in the Science, Technology, and Medicine Division. This Division employs about 41 persons plus two gratuitous persons, like me. Thirty-five are analysts, and in 1997 they produced approximately 50 written reports as well as consultations, hearings, briefings, and seminars. The subject of my study for the next month or so is the Air Force's program to mount a large laser in an aircraft for shooting down scud missiles.

CRS does face a crisis, of sorts, in the coming decade. Because of the large increase in personnel during the 1970s more than 50 percent of CRS employees will be eligible for retirement by the year 2006. In the Division of Science, Technology, and Medicine, only one of the 35 analysts is under the age of 40. With the declining budget, in real terms, hampering the hiring of new analysts the CRS faces a real challenge in maintaining its institutional memory beyond the next decade, a necessity in order to continue quality service.

Sources:

- Research and Analysis for Congress — A Historical Perspective: Appendix B of the Annual Report of the Congressional Research Service of the Library of Congress, Fiscal Year 1988, January 1989
- Annual Report of the Congressional Research Service of the Library of Congress, Fiscal Year 1997, March 1998.
- Miscellaneous information from the Division of Science, Technology, and Medicine, May 1998

Workshop on Formal Design of Safety Critical Embedded Systems (FEmSys '99)

March 15-17, 1999 • Munich, Germany
First Announcement and Call for Exhibitors

Scope of the workshop. Safety Critical Embedded Systems are a major challenge for computer engineering. The demand for embedding more functions as computer software calls for new design technologies.

Several R&D projects have been devoted to these objectives in the last years, and new formal approaches are now proposed and used operationally, which range from specification and rapid prototyping and validation, to code generation and testing. Many of these have led to new tools and development environments, which are available on the market already.

The "Workshop on Formal Design of Safety Critical Embedded Systems" aims at disseminating these technologies. It is targeted to R&D engineers who are involved in the design of embedded systems, and in particular, Safety Critical Embedded Systems. It concentrates on the various formal technologies that have been developed recently, or are under development.

The workshop is a follow-up of the very successful workshop at the same location in '97, which was well attended by engineers and developers from various industries. The workshop combines academic tutorials and user's lectures with a tool exhibition.

Topics. Tutorials and user's lecture will address the following themes:
- Hybrid modeling and simulation
- Object-orientation and reactive programming
- Synchronous programming
- Distribution of reactive programs
- Model-checking
- Tool certification and code validation

Tutorials. The tutorials will give a state of the art overview of formal methods used for the design of safety critical systems. Speakers include (with more speakers to be expected).
- A. Benveniste: Distribution of Reactive Programs
- R. Budde: Object-orientation and reactive programming
- E. Clarke: Model Checking
- L. Feijs: Tool certification and code validation
- N. Halbwachs: Synchronous Programming
- D. Harel: Object-orientation and reactive programming
- K. Mueller-Glaser: Hybrid modelling & simulation
- A. Pnueli: Tool certification and code validation

User's Lectures. User's Lectures will consist in reports of extensive experiences of formal methods in industrial applications. Emphasis will be equally put on the application and on the method used and related conclusions. Speakers include (with more speakers to be expected)
- Ph. Baufreton, Snecma
- M. Eckrich, BMW
- R. France, Motorola
- Y. Wolfstahl, IBM
- L. Fix, INTEL
- C. Bodennec, Schneider Electric
- D. Pilaud, Verilog
- R. Groz, France Telecom (CNET)

Call for Exhibitors. In addition, an exhibition will be organized, mainly for commercial tools, but also open to selected robust academic tools. Exhibition will be held throughout the first and second day of the workshop. In parallel with the exhibition, some tool presentations and results from large projects will be presented. Who should submit? Any company or university willing to demonstrate a tool relevant to the scope of FEmSys:
- Proofs, verification.
- Automatic test synthesis/analysis.
- Requirements engineering.
- Rapid prototyping.
- Code generation.
- Formalisms related to the above topics, e.g., B, Z, statecharts,
- Synchronous languages, temporal logic based formalisms

How to submit? Send a 3-5 pages abstract describing the tool. The abstract should be sent, or preferably mailed in Latex or postscript format, to:

Albert Benveniste
IRISA, Campus de Beaulieu
F 35042 Rennes cedex, France
(tel +33 99 84 72 35, email Albert.Benveniste@inria.fr)

Deadlines:
- Submission: September 30, 1998
- Acceptance: October 15, 1998

Participation fee:
- Participants from industry: DM 500
- Participants from academia: DM 300
- Industrial exhibitors: DM 500
- Academic exhibitors: DM 300

Exhibitor fee includes the including the registration fee for one participant.

Conference Site

Europaeisches Patentamt
(European Patent Office)
Erhardtstr. 27
D-80331 Muenchen

For further information contact:

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Further information can be found at our web page:
http://set.gmd.de/EES/FemSys'99.html

The Information ByWay

A Historical Perspective on Digital Computers

Jack Fisher, Seajnf@aol.com

The first all electronic data processing machine or computer, the Electronic Numerical Integrator and Computer (ENIAC), began to operate in November 1945. This machine was capable of 3000 additions, 300 multiplications, or 40 divisions per second. It was located in the basement of the Moore School of Electrical Engineering at the University of Pennsylvania in Philadelphia. Its final cost was $486,804.22. ENIAC continued to operate until October 1955 when it was turned off and dismantled. The pieces were divided between the Smithsonian, the U. S. Military Academy, the University of Michigan and the Moore School.

ENIAC was a behemoth weighing 30 tons, measuring 100 feet long, 10 feet high and 3 feet deep. It contained 17,468 vacuum tubes of 16 different types, 1500 relays, 70,000 resistors, 10,000 capacitors and 6000 switches and consumed 174 kilowatts of electric power. It was reported that all the lights in West Philadelphia would dim when ENIAC was turned on. This wasn't true, however, as the university supplied its own power. Two twenty-horsepower blowers were required to dissipate the heat produced by the vacuum tubes. The ENIAC operated with decimal numbers and stored them in vacuum tubes. Twenty tubes, acting in pairs as flip-flops, were required to store a single decimal number. Data input was by means of IBM Hollerith card readers.

With as many components as were required, reliability was an important consideration in the design of ENIAC. The life expectancy of a vacuum tube was 3000 hours if the tube was operated at the full operating voltage. Tube life could be extended significantly if the voltage was reduced. Most tubes fail during turn-on and warm-up and it was standard practice at the time not to turn equipment off. Each component was hand selected after being individually tested and screened. There are no reports that describe the operating reliability of ENIAC, but it did operate and accomplish its job for 10 years.

The ENIAC did not store instructions or programs, as we are accustomed to today. Programming was accomplished by rewiring with patch cords, resetting switches, and replacing function tables. Function tables were used to look up such variables as trigonometric functions and square roots that the machine did not have the capability to calculate. The programming process might take several hours to a few days, and was accomplished by a team of six women. These women never received the credit they deserved as the first computer programmers; their government employment code was SP (sub-professional).

The development of ENIAC took place during World War II and was highly classified. Its primary purpose was to compute artillery firing tables. A firing table provided gunners with the information they needed to aim their guns. Each firing table consisted of 3000 trajectories that predicted the flight of a projectile after it left the gun. Precise calculation of a trajectory required modeling the aerodynamic forces on the projectile that are functions of the velocity and the atmospheric density. The density itself was a function of the temperature and altitude. Firing tables were required for every gun, fuse and projectile combination.

With today's computers this is a trivial problem requiring the integration of differential equations over the time that it takes the round to travel to impact. However, in the early days of World War II it was much more difficult and was accomplished by a team of human computers each using the then available desktop electromechanical calculators. Each trajectory required a single operator from one to two days. A complete firing table would take a team of 100 people one month to complete. This is the way that firing tables were produced. The Moore School was producing these firing tables for the Ballistics Research Laboratory (BRL) at the Army's Aberdeen Proving Ground. A team of nearly 200 women was responsible for these calculations.

Another alternative for calculating ballistic trajectories was the use of a mechanical analog computer known as the differential analyzer. The Moore School had such an analyzer that was built during the 1930s with a government grant and the sponsorship of the BRL. The differential analyzer could calculate a trajectory in an hour. A firing table could therefore be produced in about a month. During World War II both the differential analyzer and the team of women were used to produce firing tables. ENIAC, when it began operation, could produce a trajectory in 30 seconds, less time than required for the flight of a projectile.

The developers of ENIAC were John Mauchly and John Presper Eckert, Jr. Mauchly, a physicist from Ursinus College near Philadelphia, came to the Moore School to take an electronics course and stayed to teach. Eckert, a research associate, had just received his master's degree in electrical engineering. Both men were familiar with the ballistics work and were collaborating on possible improvements for the differential analyzer. Mauchly wrote a paper in 1942 entitled, "The Use of High Speed Vacuum Tubes for Calculating."

The paper was lost for six months, but was recovered in March 1943 and, with additional analysis by both Mauchly and Eckert formed the basis for a contract with BRL that was signed in June 1943. The amount of that contract was $61,700.

The liaison between the Army and Moore School was provided by Herman Goldstine, a young lieutenant with a PhD in mathematics, who was familiar with the details of the ENIAC development. In a chance encounter at a railroad station in the summer of 1944, he met John von Neumann, the brilliant Austrian mathematician, who was then working at Los Alamos. Von Neumann's primary concern was the hydrodynamic modeling of the implosion required to detonate the plutonium bomb. He was very much interested in the capabilities of ENIAC as described by Goldstine, and in a subsequent visit to the Moore School learned the details of the ENIAC development and became a consultant to the team.

The three principal weaknesses of ENIAC were insufficient data storage, difficulty in reprogramming to solve another problem, and the number of vacuum tubes that were required. With the help of von Neumann, several improvements for ENIAC were proposed. These included the use of a binary system for representing numbers, the use of mercury delay line technology for storage, and the use of stored instructions or programs. The use of delay lines could reduce the number of vacuum tubes required by 80%. In October 1944, the Moore School was awarded a contract for the development of a successor to ENIAC, the Electronic Discrete Variable Automatic Computer (EDVAC). The value of the contract was $105,600. The central processor was completed in 1949 and that's as far as the EDVAC development went.

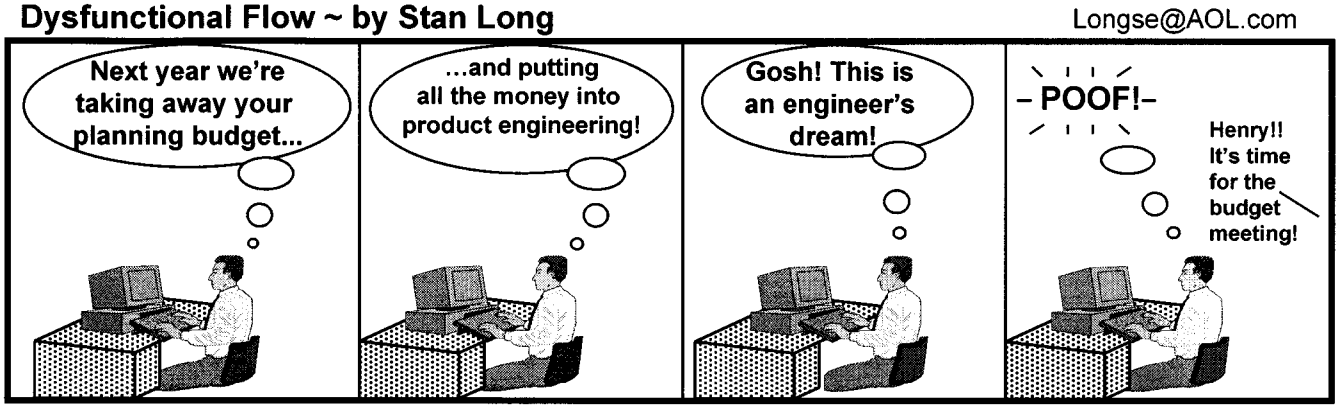
Mauchly and Eckert left the University of Pennsylvania in a dispute over patent rights in 1946. They had previously patented ENIAC but would not be allowed to continue working on EDVAC unless they signed over patent rights to the university. They left and started their own company, the Eckert-Mauchly Computing Corporation. Here they started the design of a computer for business applications, the UNIVersal Automatic Computer or UNIVAC.

Their first customer was the U.S. Census Bureau. Follow-on customers were Prudential Insurance and the A.C. Nielson market research company. Mauchly and Eckert also had a contract with Northrop to develop an airborne computer, known as the Binary Automatic Computer (BINAC), for the SNARK guided missile. This computer never met its performance requirements, but was shipped to Northrop in September 1949.

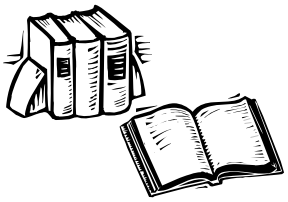
The Eckert-Mauchly firm was chronically short of funds during this period. In 1948 American Totalisator, a company that produced a mechanical computer that calculated odds for racetrack betting, bought a 40% share of their company for $500,000 and also offered financing. However, when their sponsor at American Totalisator was killed in an airplane crash, support was withdrawn. Eckert and Mauchly tried unsuccessfully to obtain support from IBM. In early 1950 their firm was bought by Remington Rand (which later became Sperry-Rand and subsequently UNISYS). The first UNIVAC was completed early in 1951 and was delivered to Census Bureau. This computer used magnetic tape storage for input and output instead of punched cards, a revolutionary concept for the time. It contained 5000 vacuum tubes and dissipated 120 kilowatts of power.

Want to read more about the history of computers? Here are the sources for the information contained in this article.

1. Joel Shurkin; *Engines of the Mind, The Evolution of the Computer from Mainframes to Microprocessors*. W. W. Norton, 1984 (revised and updated in 1996).
2. Martin Campbell-Kelly, William Aspray; Computer, *A History of the Information Machine*. Basic Books, 1996.
3. Les Freed; *The History of Computers, A Family Album of Computer Genealogy*. Ziff-Davis Press, 1995.



Do you have ideas for Stan's next cartoon? Contact him at longse@aol.com



Book Reviews

Aviation Automation: The Search for a Human-Centered Approach

Charles E. Billings, Ohio State University, Lawrence Erlbaum Associates, Publishers, Mahwah, New Jersey, 1997
Reviewed by Scott Jackson, Systems Engineering Technical Applications Committee, scott.jackson@boeing.com

Someone once observed that flying a commercial airplane consists of hours of deadly boredom punctuated by periods of sheer panic. Thus the question arises: How can the designer create a flight deck which balances these conditions? How much automation is enough to relieve the pilot of the demands of the periods of intense activity, normally flying below 10,000 feet and in the vicinity of airports, and at the same time not reduce him or her to the role of a mere observer for the rest of the flight? Charles Billings tackles these difficult questions and many more.

Billings, one of the world's foremost authorities on aviation automation, may not consider himself a systems engineer. Yet this book is essential reading for anyone, systems engineer or not, who is attempting to design a flight deck or air traffic control system to meet the demands of future commercial aviation. Perhaps a combination of instinct and professional experience led Billings to some principles fundamental to systems engineering.

First and foremost, Billings has embraced the principle, as indicated by the title, that the human is part of the system. That is, the equipment is there to serve the human, and not vice versa. Both working together will result in a superior system. Secondly, Billings does not see the flight deck (including the pilot) as the whole system. It is only part of a bigger system which includes both the aircraft and the entire traffic control system. He develops requirements for the whole system.

After taking us through a verbal journey of the history of aircraft automation, possible future automation and air traffic control, human and machine roles, and other issues, Billings reveals a set of requirements for aviation automation. This chapter, above all, will grab the attention of the systems engineer who will recognize that the requirements are stated as high-level goals rather than detailed verifiable requirements. Typical requirements are:

- "To command effectively, the human operator must be involved."
- "Functions should be automated only if there is a good reason to do so."

To get from these requirements to a flight deck design, the designer must exercise judgment. Billings exercised judgment himself when he created these requirements. What is their source? It is, of course, Billings' own professional judgment based on years of experience. There could be no better source.

What, then, is the role of the systems engineer? Billings does not, after all, tell you how to design a flight deck or air traffic control system. He only lays out the requirements. The role of the systems engineer is to use his or her own judgment to convert these requirements into verifiable requirements and then into a system. Or, better put, the systems engineer should "architect" the flight deck, in the Rechtin and Maier sense (Eberhardt Rechtin and Mark Maier, *The Art of Systems Architecting,* 1997) since the process involves those elusive and non-quantifiable aspects so central to systems architecting.

In short, Billings has laid out a roadmap to aviation automation. It is up to the systems engineer to make the journey.

Scott Jackson is a member of the Los Angeles Chapter and author of *Systems Engineering for Commercial Aircraft,* Ashgate Publishing Limited (UK), 1997 (www.ashgate.com).

System Engineering Management

Benjamin S. Blanchard, John Wiley & Sons, 1998 ISBN: 0-471-19086-1, $67
Reviewed by: Dr. Elaine M. Hall, ehall@level6software.com

"Latest and greatest" best describes the second edition of Ben Blanchard's *System Engineering Management*. The multidisciplinary domain of system engineering is exposed for what it really is — technical management. The melting pot that is the trademark of system engineering is evident in Blanchard's bibliography, which includes topic areas on reliability, human factors, logistics, and quality. It is this combination of engineering and management science that qualifies a system engineer.

Like Professor Blanchard himself, *System Engineering Management* straddles industry and academia. Professionals and students will find their questions answered in his comprehensive guide. System engineering activities are first set in a framework, which includes economic, social, political, and ecological considerations. Then, taking a life-cycle approach, Blanchard weaves systems engineering principles and tools into design and development activities.

The term "system" stems from a Greek word that means an orga-

nized whole. In this sense, *System Engineering Management* is a system for the practice of systems engineering. The book's structure provides the big picture for the systems engineering field. An introduction to systems engineering is followed by a womb-to-tomb lifecycle process. Design requirements, methods, tools, review and evaluation are addressed in detail. Systems engineering program planning tackles management issues, such as the Systems Engineering Management Plan (SEMP), Work Breakdown Structure (WBS) and Risk Management Plan (RMP). Human resource requirements are described in organization for systems engineering, which includes concurrent engineering concepts such as Integrated Product and Process Development (IPPD). Additional material highlights the evaluation and selection of suppliers, contracting for services, and supplier monitoring and control activities.

This book has it all — system engineering process, case studies, tools, checklists, and glossary. Blanchard's design review checklist is most complete, with questions on accessibility, interchangeability, mobility, and disposability. In my humble opinion (IMHO), *System Engineering Management* is an indispensable reference book for implementation and management of the systems engineering process.

Benjamin S. Blanchard is Professor Emeritus of Industrial and Systems Engineering, consultant, and former assistant dean of engineering for public service at Virginia Polytechnic Institute and State University.

Elaine M. Hall has two management degrees and two technical degrees, which qualifies her to hang around system engineers. As an adjunct assistant professor, Hall taught software project management at the Florida Institute of Technology. She is a risk management expert and a beginner at golf.

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Naval Surface Warfare Center, Dahlgren Division

THE NAVAL SURFACE WARFARE CENTER, DAHLGREN DIVISION, one of the Navy's premier research, development, test and evaluation organizations, set itself a tall task for the 21st Century. The leaders, managers and employees—many of whom work in technical areas ranging from computer science to physics and various specialties in between—are working to make the facility the leading expert in the science and engineering of naval warfare systems.

These weighty but achievable expectations are steaming along at the Division's two major sites: Dahlgren Laboratory, located in the rural Northern Neck of Virginia, and Coastal Systems Station in Panama City, Florida. Split between the two sites are some of the Navy's major weapons and weapon support programs: high profile projects like TOMAHAWK, AEGIS, SLBM, Standard Missile, Remote Minehunting System and SEAL Delivery Vehicle. In addition to those familiar names are the new generation of systems. The titles of those programs reflect the Division's future: Infrastructure Assurance, Expeditionary Warfare, Systems Technology, Amphibious Warfare, Vertical Launch Systems, 21st Century Surface Combatant, and the Decision Support Center to name a few. The list continues with undertakings like Coastal Warfare Evaluation Systems, Theater Warfare, Diving and Life Support System, Counterdrug Technology Development, Maritime Special Operations, Mine Warfare, Target Analysis and Warfare Assessment, and the Navy Operations Other Than War Technology Center. NSWCDD's goal — to provide the technical leadership, coordination and discipline to enable the Navy and Defense Department to engineer tomorrow's warfare systems — becomes more clearly defined with each day and each new program.

The decisions and actions taken by the Division are guided by the belief that NSWCDD's first job is to protect the customer by making the best technical choices in the most cost efficient manner. The organization continually prepares for the future, while responding to current needs and allowing for the integration of science and technology throughout the life cycle of the system.

The Naval Surface Warfare Center, Dahlgren Division— an important part of the Department of Defense team— provides superior, affordable products and services, developed from a systems perspective. Its people, programs and abilities are an essential part of the Navy's future success.

Systems Engineering:

The Journal of The International Council on Systems Engineering

Call for Papers

The ***Systems Engineering*** journal is intended to be a primary source of multidisciplinary information for the system engineering and management of products and services, and processes of all types. System engineering activities involve the technologies and system management approaches needed for:

- **definition of systems**, including identification of user requirements and technological specifications;
- **development of systems**, including conceptual architectures, tradeoff of design concepts, configuration management during system development, integration of new systems with legacy systems, integrated product and process development; and
- **deployment of systems**, including operational test and evaluation, maintenance over an extended lifecycle, and reengineering.

The ***Systems Engineering*** journal is the archival journal of, and exists to serve the following objectives of, the **International Council on Systems Engineering** (INCOSE).

- To provide a focal point for dissemination of systems engineering knowledge.
- To promote collaboration in systems engineering education and research.
- To encourage and assure establishment of professional standards for integrity in the practice of systems engineering.
- To improve the professional status of all those engaged in the practice of systems engineering.
- To encourage governmental and industrial support for research and educational programs that will improve the systems engineering process and its practice.

The Journal supports these goals by providing a continuing, respected publication of peer-reviewed results from research and development in the area of systems engineering. Systems engineering is defined broadly in this context as an interdisciplinary approach and means to enable the realization of successful systems that are of high quality, cost-effective, and trustworthy in meeting customer requirements.

The ***Systems Engineering*** journal is dedicated to all aspects of the engineering of systems: technical, management, economic, and social. It focuses on the life cycle processes needed to create trustworthy and high quality systems. It will also emphasize the systems management efforts needed to define, develop, and deploy trustworthy and high quality processes for the production of systems. Within this, ***Systems Engineering*** is especially concerned with evaluation of the efficiency and effectiveness of systems management, technical direction, and integration of systems. ***Systems Engineering*** is also very concerned with the engineering of systems that support sustainable development. Modern systems, including both products and services, are often very knowledge intensive, and are found in both the public and private sectors. The Journal emphasizes strategic and program management of these, and the information and knowledge base for knowledge principles, knowledge practices, and knowledge perspectives for the engineering of systems. Definitive case studies involving systems engineering practice are especially welcome.

The Journal is a primary source of information for the systems engineering of products and services that are generally large in scale, scope, and complexity. ***Systems Engineering*** will be especially concerned with process or product line related efforts needed to produce products that are trustworthy and of high quality, and which are cost effective in meeting user needs. A major component of this is system cost and operational effectiveness determination, and the development of processes that assure products that are cost effective. This requires the integration of a number of engineering disciplines necessary for the definition, development, and deployment of complex systems. It also requires attention to the lifecycle process used to produce systems, and the integration of systems, including legacy systems, at various architectural levels. In addition, appropriate systems management of information and knowledge across technologies, organizations, and environments is also needed to insure a sustainable world.

The Journal will accept and review submissions in English from any author, in any global locality, whether or not the author is an INCOSE member. A body of international peers will review all submissions, with potential author revisions as recommended by reviewers, with the intent to achieve published papers that:

- Relate to the field of systems engineering
- Represent new, previously unpublished work
- Advance the state of knowledge of the field
- Conform to a high standard of scholarly presentation

Editorial selection of works for publication will be made based on content, without regard to the stature of the authors. Selections will include a wide variety of international works, recognizing and supporting the essential breadth and universality of the field. Final selection of papers for publication, and the form of publication, shall rest with the Editor.

The journal became a quarterly publication during the second quarter of 1998 and four issues are anticipated in 1998. Submission of quality papers for review is strongly encouraged. The review process is estimated to take three to five months. Five copies of your manuscript should be submitted for review purposes to:

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